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• **PROJECTS • THEORY •**
• **NEWS • COMMENT •**
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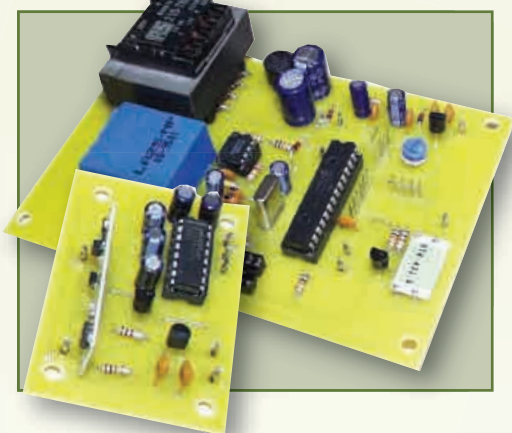
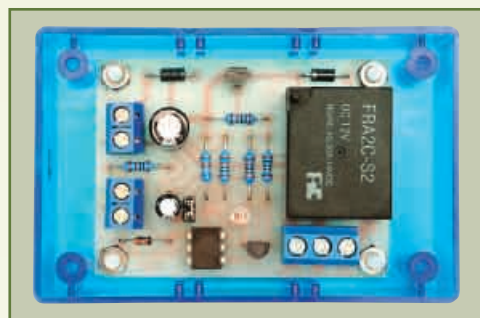
August 2008

EPE EVERYDAY PRACTICAL ELECTRONICS

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Our September 2008 issue will be published on Thursday 14 August 2008, see page 72 for details.

Everyday Practical Electronics, August 2008

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PIC & ATMEL Programmers

We have a wide range of low cost PIC and ATMEL Programmers. Complete range and documentation available from our web site.

Programmer Accessories:

40-pin Wide ZIF socket (ZIF40W) £14.95
18Vdc Power supply (PSU010) £18.95
Leads: Parallel (LDC136) £3.95 / Serial (LDC441) £3.95 / USB (LDC644) £2.95

NEW! USB & Serial Port PIC Programmer



USB/Serial connection. Header cable for ICSP. Free Windows XP software. See website for PICs supported. ZIF Socket and USB lead extra. 18Vdc.

Kit Order Code: 3149KT - **£39.95**

Assembled Order Code: AS3149 - **£49.95**

NEW! USB 'All-Flash' PIC Programmer

USB PIC programmer for all 'Flash' devices. No external power supply making it truly portable. Supplied with box and Windows XP Software. ZIF Socket and USB lead not incl.



Assembled Order Code: AS3128 - **£44.95**

Assembled with ZIF socket Order Code: AS3128ZIF - **£59.95**

'PICALL' ISP PIC Programmer



Will program virtually all 8 to 40 pin serial-mode AND parallel-mode (PIC15C family) PIC microcontrollers. Free Windows software. Blank chip auto detect for super fast bulk programming. Optional ZIF socket.

Assembled Order Code: AS3117 - **£24.95**

Assembled with ZIF socket Order Code: AS3117ZIF - **£39.95**

ATMEL 89xxx Programmer



Uses serial port and any standard terminal comms program. 4 LED's display the status. ZIF sockets not included. Supply: 16Vdc.

Kit Order Code: 3123KT - **£24.95**

Assembled Order Code: AS3123 - **£34.95**

Introduction to PIC Programming

Go from complete beginner to burning a PIC and writing code in no time! Includes 49 page step-by-step PDF Tutorial Manual, Programming Hardware (with LED test section), Win 3.11—XP Programming Software (Program, Read, Verify & Erase), and 1 rewritable PIC16F84A that you can use with different code (4 detailed examples provided for you to learn from). PC parallel port.



Kit Order Code: 3081KT - **£16.95**

Assembled Order Code: AS3081 - **£24.95**

PIC Programmer Board

Low cost PIC programmer board supporting a wide range of Microchip® PIC™ microcontrollers. Requires PC serial port. Windows interface supplied. Kit Order Code: VK8076KT - **£21.95**



PIC Programmer & Experimenter Board

The PIC Programmer & Experimenter Board with test buttons and LED indicators to carry out educational experiments, such as the supplied programming examples. Includes a 16F627 Flash Microcontroller that can be reprogrammed up to 1000 times for experimenting at will. Software to compile and program your source code is included. Kit Order Code: VK8048KT - **£22.95**
Assembled Order Code: VVM111 - **£39.95**



Controllers & Loggers

Here are just a few of the controller and data acquisition and control units we have. See website for full details. 12Vdc PSU for all units: Order Code PSU445 £8.95

USB Experiment Interface Board

5 digital input channels and 8 digital output channels plus two analogue inputs and two analogue outputs with 8 bit resolution.



Kit Order Code: VK8055KT - **£20.95**

Assembled Order Code: VVM110 - **£39.95**

Rolling Code 4-Channel UHF Remote

State-of-the-Art. High security. 4 channels. Momentary or latching relay output. Range up to 40m. Up to 15 Tx's can be learnt by one Rx (kit includes one Tx but more available separately). 4 indicator LED's. Rx: PCB 77x85mm, 12Vdc/6mA (standby). Two & Ten Channel versions also available.



Kit Order Code: 3180KT - **£44.95**

Assembled Order Code: AS3180 - **£54.95**

Computer Temperature Data Logger

Serial port 4-channel temperature logger. °C or °F. Continuously logs up to 4 separate sensors located 200m+ from board. Wide range or tree software applications for storing/using data. PCB just 45x45mm. Powered by PC. Includes one DS1820 sensor.



Kit Order Code: 3145KT - **£17.95**

Assembled Order Code: AS3145 - **£24.95**

Additional DS1820 Sensors - **£3.95 each**

Most items are available in kit form (KT suffix) or pre-assembled and ready for use (AS prefix).

4-Ch DTMF Telephone Relay Switcher

Call your phone number using a DTMF phone from anywhere in the world and remotely turn on/off any of the 4 relays as desired. User settable Security Password, Anti-Tamper, Rings to Answer, Auto Hang-up and Lockout. Includes plastic case. 130 x 110 x 30mm. Power: 12Vdc. Kit Order Code: 3140KT - **£54.95**
Assembled Order Code: AS3140 - **£69.95**



8-Ch Serial Port Isolated I/O Relay Module

Computer controlled 8 channel relay board. 5A mains rated relay outputs and 4 opto-isolated digital inputs (for monitoring switch states, etc). Useful in a variety of control and sensing applications. Programmed via serial port (use our new Windows interface, terminal emulator or batch files). Serial cable can be up to 35m long. Includes plastic case 130x100x30mm. Power: 12Vdc/500mA. Kit Order Code: 3108KT - **£54.95**
Assembled Order Code: AS3108 - **£64.95**



Infrared RC 12-Channel Relay Board



Control 12 onboard relays with included infrared remote control unit. Toggle or momentary. 15m+ range. 112 x 122mm. Supply: 12Vdc/0.5A

Kit Order Code: 3142KT - **£47.95**

Assembled Order Code: AS3142 - **£59.95**

Audio DTMF Decoder and Display



Detect DTMF tones from tape recorders, receivers, two-way radios, etc using the built-in mic or direct from the phone line. Characters are displayed on a

16 character display as they are received and up to 32 numbers can be displayed by scrolling the display. All data written to the LCD is also sent to a serial output for connection to a computer. Supply: 9-12V DC (Order Code PSU445). Main PCB: 55x95mm.

Kit Order Code: 3153KT - **£24.95**

Assembled Order Code: AS3153 - **£34.95**

Telephone Call Logger

Stores over 2,500 x 11 digit DTMF numbers with time and date. Records all buttons pressed during a call. No need for any connection to computer during operation but logged data can be downloaded into a PC via a serial port and saved to disk. Includes a plastic case 130x100x30mm. Supply: 9-12V DC (Order Code PSU445).



Kit Order Code: 3164KT - **£54.95**

Assembled Order Code: AS3164 - **£69.95**

Hot New Products!

Here are a few of the most recent products added to our range. See website or join our email Newsletter for all the latest news.

Bipolar Stepper Motor Chopper Driver

New bipolar chopper driver gives better performance from your stepper motors. It uses a dual full bridge motor driver based on SGS Thompson chips L297 & L298. Motor current for each phase is set using an on-board potentiometer. Can handle motor winding currents of up to 2 Amps per phase. Operates from a DC supply voltage of 9-36V. All basic motor controls provided including full or half stepping of bipolar steppers and direction control. Synchronisable when using multiple drivers. Perfect for desktop CNC applications.

Kit Order Code: 3187KT - **£29.95**

Assembled Order Code: AS3187 - **£39.95**



Shaking Dice

This electronic construction kit is great fun to build and play with. Simply shake and watch it slowly roll to stop on a random number.

Kit Order Code: VMK150KT - **£9.95**



Running MicroBug

This electronic construction kit is an attractive bright coloured bug-shaped miniature robot. The microbug is always hungry for light and travels toward it!

Kit Order Code: VMK127KT - **£9.95**



Video Signal Cleaner

Digitally cleans the video signal and removes unwanted distortion in video signal. In addition it stabilises picture quality and luminance fluctuations.

You will also benefit from improved picture quality on LCD monitors or projectors.

Kit Order Code: VK8036KT - **£19.95**

Assembled Order Code: VVM106 - **£26.95**



PC Interface Board

This interface card excels in its simplicity of use and installation. The card is connected in a very simple way to the printer port (there is no need to open up the computer). Likewise there is no need to install an extra printer port, even if a printer is to be used. This can be connected to the card in the usual manner. Connection to the computer is optically isolated, so that damage to the computer from the card is not possible.

Kit Order Code: VK8000KT - **£59.95**



Most items are available in kit form (KT suffix) or assembled and ready for use (AS prefix).

Motor Speed Controllers

Here are just a few of our controller and driver modules for AC, DC, Unipolar/Bipolar stepper motors and servo motors. See website for full details.

DC Motor Speed Controller (100V/7.5A)



Control the speed of almost any common DC motor rated up to 100V/7.5A. Pulse width modulation output for maximum motor torque

at all speeds. Supply: 5-15Vdc. Box supplied.

Dimensions (mm): 60Wx100Lx60H.

Kit Order Code: 3067KT - **£13.95**

Assembled Order Code: AS3067 - **£21.95**

PC / Standalone Unipolar Stepper Motor Driver

Drives any 5, 6 or 8-lead unipolar stepper motor rated up to 6 Amps max. Provides speed and direction control. Operates in stand-alone or PC-controlled mode. Up to six 3179 driver boards can be connected to a single parallel port. Supply: 9Vdc. PCB: 80x50mm.

Kit Order Code: 3179KT - **£12.95**

Assembled Order Code: AS3179 - **£19.95**



Bi-Polar Stepper Motor Driver

Drive any bi-polar stepper motor using externally supplied 5V levels for stepping and direction control. These usually come from software running on a computer.

Supply: 8-30Vdc. PCB: 75x85mm.

Kit Order Code: 3158KT - **£17.95**

Assembled Order Code: AS3158 - **£27.95**



Bidirectional DC Motor Controller



Controls the speed of most common DC motors (rated up to 32Vdc/10A) in both the forward and reverse direction. The

range of control is from fully OFF to fully ON in both directions. The direction and speed are controlled using a single potentiometer. Screw terminal block for connections.

Kit Order Code: 3166v2KT - **£17.95**

Assembled Order Code: AS3166v2 - **£27.95**

AC Motor Speed Controller (700W)

Reliable and simple to install project that allows you to adjust the speed of an electric drill or single phase 230V AC motor rated up to 700 Watts.

Simply turn the potentiometer to adjust the motors RPM. PCB: 48x65mm. Not suitable for use with brushless AC motors.

Kit Order Code: 1074KT - **£12.95**

Assembled Order Code: AS1074 - **£18.95**

Box Order Code 2074BX - **£5.95**



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Order Code EPL500 - **£149.95**

Also available - 30-in-1 £16.95, 50-in-1 £21.95, 75-in-1 £32.95 £130-in-1 £39.95 & 300-in-1 £59.95 (details on website)



Tools & Test Equipment

We stock an extensive range of soldering tools, test equipment, power supplies, inverters & much more - please visit website to see our full range of products.

Two-Channel USB Pc Oscilloscope

This digital storage oscilloscope uses the power of your PC to visualize electrical signals. Its high sensitive display resolution, down to 0.15mV, combined with a high bandwidth and a sampling frequency of up to 1GHz are giving this unit all the power you need.

Order Code: VPCSU1000 - **£289.95**



Personal Scope 10MS/s

The Personal Scope is not a graphical multimeter but a complete portable oscilloscope at the size and the cost of a good multimeter. Its high sensitivity - down to 0.1mV/div - and extended scope functions make this unit ideal for hobby, service, automotive and development purposes. Because of its exceptional value for money, the Personal Scope is well suited for educational use.

Order Code: VHPS10 - **£129.95 £119.95**

See website for more super deals!



www.QuasarElectronics.com

Secure Online Ordering Facilities • Full Product Listing, Descriptions & Photos • Kit Documentation & Software Downloads

POPULAR KITS

These are some of our most popular kits and there is something for everyone. They are designed for ease of construction and robust reliability. All of our kits are supplied with quality fibreglass PCBs, board components and clear English instruction. Jaycar kits can be built with confidence.

PC Link for Automatic Control

KV-3590 £18.95 + post & packing

Automate your house, switch on garden lighting, turn on sprinklers or even control your household heating with this terrific kit. Each SPDT relay can handle 10 amps and has an LED to show whether it is on or off. Software is provided on a 3.5 disk. Kit includes PCB, relays, software, and all electronic components. 8 - 12V DC power required.



Automotive Headlight Reminder Kit

KC-5317 £7.75 + post & packing

Nothing is more frustrating than getting into your car to discover that you had left your headlights on and the car's battery is flat. This kit will warn you if the lights are still on when the ignition has been switched off. Features optional door switch detection, time-out alarm and a short delay before the alarm sounds. Supplied with PCB and electronic components.



Subwoofer Controller Kit

KC-5452 £29.00 + post & packing

Using this kit to control your external speaker and sub-amplifier can give you loads of bass without taking up much space. The kit has all the features you could want, including low and high pass filters, parametric equaliser and auto-turn on for external equipment. The controller is 12 volt DC powered and can also be used in automotive applications.

- Kit supplied with silk screened PCB and processed panels.



Universal Speaker Protection and Muting Module Kit

KC-5450 £8.75 + post & packing

Protects your expensive speakers against damage in the event of catastrophic amplifier failure such as a shorted output transistor. In addition, the circuit also banishes those annoying thumps that occur when many amplifiers are switched on or off, especially when the volume is set to a high level. The design also incorporates an optional over temperature heat-sensor that will disconnect the speakers if the output stage gets too hot. Configurable for supply voltages between 22VDC-70VDC.

Supplied with a silk screened PCB, relay and all electronic components.



RFID Security Module Receiver Kit

KC-5393 £28.95 + post & packing

Radio Frequency Identity (RFID) is a contact free method of controlling an event such as a door strike or alarm etc. An "RFID Tag" transmits a unique code when energised by the receiver's magnetic field. As long as a pre-programmed tag is recognised by the receiver, access is granted. This module provides normally open and normally closed relay contacts for flexibility. It works with all EM-4001 compliant RFID tags. Kit supplied with PCB, tag, and all electronic components.

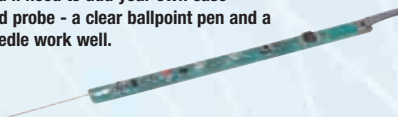
- As published in
Everyday Practical
Electronics Magazine
August 2007



PIC Based Logic Probe

KC-5457 £4.50 + post & packing

Unlike ordinary logic probes, this one is driven by a PIC processor and operates over a wide supply voltage of 2.8VDC to 5VDC. It is extremely compact and uses surface mount devices on a PCB only 5mm wide. The probe includes a 'pulse stretcher' that will let you see very short pulses and a latch function to 'hold' infrequent pulses. Kit includes PCB and all specified electronic components including pre-programmed PIC. You'll need to add your own case and probe - a clear ballpoint pen and a needle work well.

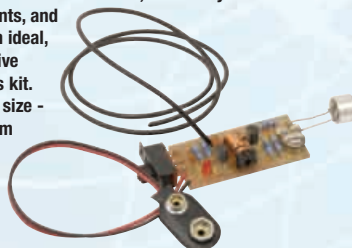


Mini FM Transmitter

KE-4711 £3.70 + postage & packing

This unit is a two transistor two stage transmitter that has the benefits of being VERY COMPACT.

- The Jaycar kit contains PCB, 9V battery and all components, and makes an ideal, inexpensive beginners kit.
- PC board size - 45 x 22mm



Voltage Monitor Kit

KC-5424 £6.00 + post & packing

This versatile kit will allow you to monitor the battery voltage, the airflow meter or oxygen sensor in your vehicle. The kit features 10 LEDs that light up in response to the measured voltage, preset 9-16V, 0-5V or 0-1V ranges complete with a fast response time, high input impedance and auto dimming for night driving. Kit includes PCB with overlay, LEDs, all electronic components and clear English instructions.

- Requires 12VDC power



Recommended box UB5
(HB-6015) £0.83 each

SHORT CIRCUITS

Short Circuits is a learning system that was developed by Jaycar to introduce young readers to the exciting world of electronics. The system is implemented across a series of three books and takes the reader from novice to experienced constructor. Volume one even includes the parts required to construct all the projects described in the book.

Short Circuits Book I Including Parts

KJ-8502 £11.95 + post & packing

This full colour 96 page book has over 100 drawings and diagrams. The projects are fun to build and relevant to the electronics scene in the new millennium. Included with the book, you get the baseboard, plenty of spring terminals and ALL the components required to build every project in the book, INCLUDING the bonus projects. Book measures 205mm x 275mm



Short Circuits Book - Volume II

BJ-8504 £4.00 + post & packing

Once you have the basic skills and knowledge from tackling Short Circuits Vol 1, you can now have some real fun! With this book (and associated project packs available separately) you can make such things as; a mini strobe light, police siren, mini organ, a couple of powerful radio transmitters, an FM radio - even a 'Knight Rider' scanner!! All components are fully described and explained, along with tutorials on soldering iron and multimeter use. All projects are safe and battery powered. Softcover - full colour 205 x 275mm.



Short Circuits Volume III

BJ-8505 £7.99 + post & packing

This is the definitive electronics training manual and presents more than 30 individual printed circuit board-based construction projects. Each project contains a full technical description, with experimental changes to each circuit also explained. This book will give you the knowledge and skill that will elevate you into a fully fledged constructor! Softcover - full colour 128 pages. 205 x 275mm.



More Information? Secure Ordering?

www.jaycarelectronics.co.uk

Great Kits for Electronic Enthusiasts

Popular Project Kits

Universal Stereo Preamplifier Kit

KC-5159 £5.25 + post and packing

Based around the low noise LM833 dual op-amp IC, this preamp is designed for use with a magnetic cartridge, cassette deck or dynamic microphone. It features RIAA/IEC equalisation, and is supplied with all components to build either the phono, tape or microphone version.

- Measuring only 80 x 78 x 30mm, it is ideal for incorporating into existing equipment and is supplied short form with PCB and specified components plus PCB standoffs for mounting.

- +/- 15VDC required



Three Stage FM Transmitter

KJ-8750 £6.50 + post & packing

This is a Three-Stage radio transmitter that is so stable you could use it as your personal radio station and broadcast all over your house. Great for experiments in audio transmission. Includes a mic, PCB with overlay and all other parts.

- Requires 9V battery (not included)
- Instructions included in kit

Thousands Sold



"Minivox" Voice Operated Relay

KC-5172 £4.95 + post and packing

Voice operated relays are used for 'hands free' radio communications and some PA applications etc. This tiny kit fits into the tightest spaces and has almost no turn-on delay. 12VDC @ 35mA required. Kit is supplied with PCB electret mic, and all specified components.

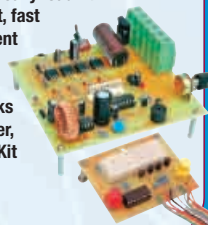
- Just 50 x 50 x 15mm



12-24V High Current Motor Speed Controller Kit

KC-5465 £23.25 + post & packing

Want to control a really big DC motor? This design will control 12 or 24VDC motors at up to 40A continuous. The speed regulation is maintained under load, so the motor speed is maintained even under heavy load. It also features automatic soft-start, fast switch-off, a 4-digit LED 7-segment display to show settings, an overload warning buzzer and a low battery alarm. All control tasks are monitored by a microcontroller, so the functionality is extensive. Kit contains PCB and all specified electronic components.



Smart Card Reader and Programmer Kit

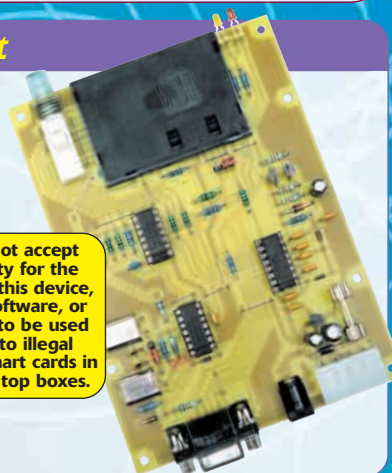
KC-5361 £15.95 + post & packing

Program both the microcontroller and EEPROM in the popular gold, silver and emerald wafer cards. Card used needs to conform to ISO-7816 standards, which includes ones sold by Jaycar. Powered by 9-12 VDC wall adaptor or a 9V battery. Instructions outline software requirements that are freely available on the internet. Kit supplied with PCB, wafer card socket and all electronic components. PCB measures: 141 x 101mm.

- As published in *Everyday Practical Electronics* May 2006

Requires 9-12VDC wall adaptor (Maplin #UG01B £13.99)

Jaycar cannot accept responsibility for the operation of this device, its related software, or its potential to be used in relation to illegal copying of smart cards in cable TV set top boxes.



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£50 - £99.99	£10	£500+	£40
£100 - £199.99	£20		
Max weight 12lb (5kg). Heavier parcels POA.			
Minimum order £10.			

Note: Products are despatched from Australia, so local customs duty and taxes may apply.

How to order:

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Email: techstore@jaycarelectronics.co.uk

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How To Order

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- ALL PRICING IN POUNDS STERLING
- MINIMUM ORDER ONLY £10



Experiment

Wind Powered Generator Experimenters Kit

KJ-6696 £15.95 + post & packing

Learn all about this green energy source, and the mechanics of wind generators. It is supplied in kit form, so you get to assemble the whole thing before you start learning about how it works.

- Approximately 300mm tall



Solar Car Kit

KJ-8920 £7.25 + post & packing

This terrific little car is fun to build and will introduce young minds to the concepts of mechanical construction and solar electric propulsion. It can run purely from solar power or from the included hand-cranked generator. Great fun for years 8+

- Forward and reverse control
- Approx 200mm long



Solar Eco-House Kit

KJ-8924 £7.25 + post & packing

The house is fun to build and will introduce your child to the eco-friendly concepts in a deceptively entertaining way. It has its own solar panel and a windmill to supply free power to the lighting & sound circuits, or it can run from ordinary batteries. Simple and safe for ages 8+.

- Requires 2 x AA batteries for no-solar operation.



Deluxe Solar Educational Kit

KJ-6694 £7.95 + postage & packing

A series of do-it-yourself experiments to acquire the basic knowledge of solar power. Includes solar cell module, musical unit, plastic lamp, motor accessories and plastic adaptors.



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PCB Production - Development

Size	Tracks/Holes	
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PCB Production - Drafting Materials

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Soldering Irons

We carry in stock a wide range of soldering iron and soldering accessories. Irons from 12 to 100 Watts.

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Basic 165 x 18mm	£2.85
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Soldering Station

A 48W adjustable temperature soldering station with a rotary dial, LED Temperature metering, on-off switch, iron holder and tip cleaning sponge. This station features accurate heat sensing for instant compensation & stable temperatures. Adjustable temperature range of 150 - 420°C. Low voltage iron with Silicone cable. Supply: 240V, Iron: 24V 48W

Model 167-540 £49.00

Soldering Station

A 48W adjustable temperature soldering station with a rotary dial, Digital Temperature Indication, on-off switch, iron holder and tip cleaning sponge. This station features accurate heat sensing for instant compensation & stable temperatures. Adjustable temperature range of 150 - 480°C. Low voltage iron with Silicone cable. Supply: 240V, Iron: 24V 48W

Model 167-570 £52.23

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Model: 121-120

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DC voltage 200mV - 1000V (±0.5%)
AC volts 2V - 700V (±0.8%)
DC current 2mA - 20A (±1.2%)
AC current 200mA - 20A (±1.8%)
Resistance 200 Ohms - 20M Ohms (±0.8%)
Capacitance 2000pF - 20µF (±2.5%)
Temperature 0°C - 1000°C (±1.5%)
Frequency 20kHz (±1%)
Max display 1999
Power supply 9V (PP3 battery)
Dimensions 88 x 173 x 40 mm

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We carry a large range of the photographic & chemical processing equipment for PCB production, a full list with full technical specifications is available in our catalogue or visit our web site.

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229 x 159mm working area

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Process tanks feature electrically operated pumps and/or heaters

with thermostat control, suitable.

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PCB Production - Tools

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SPECIAL PRICE £31.02

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0-50mA 10Ω

0-100mA 0065

0-500mA 0012

0-1A 60mΩ

0-3A 20mΩ

0-5A 12mΩ

0-15A 4mΩ

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Single & Double 1.6mm 305g/m²

100 x 160mm Single £1.06

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220 x 233mm Single £3.50

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233 x 220mm £6.86 £7.70

PCB Production - Chemicals

100ml Aerosol Photoresist spray, covers 2m² £5.12

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500g Powder developer, makes 10lt £7.08

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500g Ferric Chloride Pellets, makes 1lt £3.04

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We carry a wide range of specialist tools for the electronics industry including:

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26 Way £0.26 £13.94

34 Way £0.34 £18.22

40 Way £0.40 £21.44

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UTP Cable

Conforms to CAT5E

100MHz standard,

ETA verified TIA/EIA 568-B.2

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2 Module Blank £0.45

Other keystone outlets, switches & accessories available. Patch & Cross-over leads from £0.50

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IDC & trim tool £4.94

Outlets

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1 Gang Plate (2 Mods) £0.50

2 Gang Plate (4 Mods) £0.88

½ Module Blank £0.25

1 Module Blank £0.35

2 Module Blank £0.45

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Station Road
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Tyne & Wear
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Editorial Offices:
EVERYDAY PRACTICAL ELECTRONICS EDITORIAL
Wimborne Publishing Ltd., Sequoia House, 398a Ringwood Road,
Ferndown, Dorset BH22 9AU
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Give a little, help a lot

In mid-June, I attended a fascinating conference in Westminster, entitled Energy and Environment 2008. It brought together an eclectic collection of environmental, political and engineering groups to discuss and debate the usual suspects of energy use, energy supply and global warming. Now, EPE is not really the place for pontificating on climate change – I'm sure you all have your own opinions on cause, effect and solutions – so don't worry, I'm not going to lecture you. However, one stand in the accompanying exhibition did catch my eye, and I think it is well worth highlighting.

Computer Aid International (CAI) is a charity that takes in unwanted IT equipment – mostly of course PCs – and sends them to help schools, colleges and other not-for-profit organisations in the developing world. CAI professionally wipes all hard disks using 'Blanco data destruction', cleans and services the computers, installs new software and sends them off for a new lease of life. The result is fewer machines in landfill, less pollution and a real leg up for those much less fortunate than ourselves. Many of the refurbished machines use Linux, but they also install Windows and have a deal with Microsoft for a very cheap purchase price.

If, like me, you are a bit of a techno hoarder (I'm embarrassed to say I've got two dust-collecting silicon dinosaurs) then perhaps you have an old PC you no longer need. Why not think about sending it off to CAI. (The charity also takes in monitors, printer cartridges and mobile phones.) CAI does ask for a donation to support delivery to their London collection point, but it's a small price to pay for safe destruction of data and the knowledge that your 'old and useless' computer is in fact genuinely useful and helping to educate a class of children.

In a throwaway society like ours, I do feel this is a win-win for all of us. You can find further details of CAI at their website: www.computeraid.org

Muir

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Editor: MATT PULZER

Consulting Editors: DAVID BARRINGTON
JOHN BECKER

Subscriptions: MARILYN GOLDBERG

General Manager: FAY KEARN

Editorial/Admin: (01202) 873872

Advertising and Business Manager:

STEWART KEARN (01202) 873872

On-line Editor: ALAN WINSTANLEY

EPE Online (Internet version) Editors:

CLIVE (Max) MAXFIELD and ALVIN BROWN

Publisher: MIKE KENWARD

READERS' TECHNICAL ENQUIRIES

Email: techdept@epemag.wimborne.co.uk

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All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.

A number of projects and circuits published in EPE employ voltages that can be lethal. You should not build, test, modify or renovate any item of mains-powered equipment unless you fully understand the safety aspects involved and you use an RCD adaptor.

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We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

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NEWS

A roundup of the latest Everyday
News from the world of
electronics



Freesat now on air

Barry Fox reports on the UK's new free satellite service Freesat

THE UK's free satellite service *Freesat* has now gone on air. Viewers who cannot get the DTTV Freeview service – because signal quality is poor or non-existent in 25% of the country – can now get all the Freeview programmes, plus some extra channels and HD, through a dish antenna. See www.freesat.co.uk/

In a thinly disguised snipe at Sky, which offers its own *Sky Freesat* service, but uses it as a marketing tool to sell subscriptions, Emma Scott, managing director of the new Freeview/Freesat service, promises “A guaranteed free service for a one off payment and no follow up hassle calls.”

The Freesat programme line-up starts with 80 TV and radio channels, including all the BBC and ad-supported channels currently on Freeview DTTV, with the addition of a few extra movie and news channels, including Movies4Men and Al-Jazeera English. Around 200 Freesat channels are promised by the end of the year; the contracts are signed and channels added at around 20 per month.

Regional variations

Viewers will be able to see the regional variations of BBC and ITV programmes, normally only broadcast locally on terrestrial masts. During initial box set-up the viewer enters their home postcode and the box then defaults to the local region programming. There is no room for HD on DTTV, and Freesat already carries one HD channel from the BBC and the promise of another from ITV “within a few weeks”. The ITV HD channel, claim Emma Scott and Commercial Development Director Richard Lindsay-Davis, is ‘exclusive’ to Freesat for an unspecified time, while Channel 4 HD remains ‘exclusive’ to Sky, also for an unspecified time. “We are talking to others” says Lindsay-Davis.

James Atkins, Freesat's Trade Marketing Manager explains that ITV HD exclusivity means the service is ‘a red button service’ accessed through MHEG interactivity options displayed on screen.

Freesat has its own seven-day on-screen electronic programme guide. Freesat's EPG looks very similar to the Freeview EPG, with similar text news

and information, but access is much faster thanks to greater bandwidth. Michael Grade, Executive Chairman, ITV plc, promises: “An unrivalled line-up of premium football, including the FA Cup, England internationals and UEFA Champions League from next season.”

Although Sky and Freesat will share some transmission feeds, the EPGs are different, so Freesat viewers will not see Sky programmes listed, whereas Sky Freesat viewers see a list of the programmes they could watch if they paid.

HD receivers

Receivers from Alba (under the Bush, Goodmans and Grundig names) will be available in SD and HD versions; Humax is offering an HD box and Panasonic launched an HD Freesat IDTV in June. Contrary to misleading statements made at the press launch, none of the boxes has a phone socket but all have an ethernet port. Viewers will be encouraged to plug in with the promise of ‘exciting services’ such as IPTV in the future.

Prices start from around £50 for an SD box and £120 for HD. “Non-branded receivers won't pick up all services” warns Lindsay-Davis. Freesat dares not guarantee that anyone with a Sky dish will be able to use it with a Freesat box; this is because the Freesat services are spread between *Astra* 2D at 28.2°E, as used by Sky and with a tight UK footprint, and *Eurobird* at 28.8°E, which has a wider footprint. Dishes which are badly aligned on 28.2° may be even more off axis for 28.8°, and give problems for Freesat. Freesat promises to offer advice on which channels are the most likely to test a system. Alba and Humax promise Freesat recorders ‘later this summer’.

Freesat has stuck deals with major high street outlets Argos, Comet, Currys and John Lewis, plus some independent retailers. “Installation is very important” says Lindsay-Davis. “Retailers can also arrange installation by approved installers.” Emma Scott says this will cost “from £80, including the dish”. John Lewis says “standard installation costs £100”.

Installation

We asked Lindsay-Davis to elaborate on how customers can avoid buying receivers that they then try and plug into ordinary TV aerials and perhaps risk life and limb by trying to fit their own dishes. “We have not trivialised this” says Lindsay-Davis. “After customers buy a receiver they will be called by an installer who will go through a list of questions. We are not pushing this as plug and play”.

John Edwards, director of communications for the Alba Group, and Chairman of the Consumer Electronics Council of industry body Intellect, says “We recognise that things could go wrong. You never know for sure until you go live. We have an assessment system in place to monitor help line queries. We learned lessons with Freeview and with digital radios for cars – which unexpectedly would not work with the aerials that come fitted to many cars. It's a learning experience but we have got the assessment issue covered”.

Installation cost estimates are based on a 45cm dish, with single LNB, fitted at second floor level with 15m of cable. Freesat believes 85% of installations will fall in this category. James Atkins assures that if customers buy a receiver, and then find installation is much more expensive they will be able to take their box back and get a refund.

Confusion

On the day following launch we visited a flagship Dixons Currys Digital store in London's Oxford Street. A Freesat Humax HD box was on display, amongst 11 DTTV Freeview boxes, piles of boxed DTTV Freeview products and signs explaining DTTV Freeview reception. There was no sign to explain that the Freesat receiver needed a different aerial from the Freeview receivers and when we asked an assistant whether the HD receiver would work with an existing TV aerial he pointed to a Freeview sign and told us to check the Freeview coverage area.

FireFly Radio

'FireFly' radio remote control systems provide security and versatility. RF Solutions has launched a new remote control system housed in a rugged IP68 weatherproof enclosure. Delivering a transmitting range of up to 100 metres, the general purpose 'FireFly' module can be used in a variety of applications, including lighting control, remote switching, industrial remote switching and access control. Each individual switch on each of the transmitters may be paired with any or all of the receiver relay outputs. The receiver has the capacity to learn up to 15 transmitter button pairings, which are remembered even if the power is removed.

Installation simply requires connections to power supply and the output relay screw terminals. The output relays are activated by the button press on the transmitter encoder. The decoder is supplied in an IP68-rated enclosure with cable gland and wall mounting lugs. This 'FireFly' unit is designed to be a fixed installation operated from either 12/24V DC or 230V AC.

Each 'FireFly' transmitter has a unique identity. Every time a switch is pressed, the transmitter emits a highly secure RF signal



(which appears as a random encrypted data stream). The receiver can learn this encrypted signal and allocate it to an output. Any transmitter switch may be paired to one or many of the receiver's outputs, or a transmitter single switch may be paired to any number of

receiver's outputs to enable a powerful and flexible remote control system. The same transmitter may be taught to work with any number of receivers to create 'master keys'.

Visit www.rfsolutions.co.uk for more information.

CLASS-D DESIGN

Midlands-based company Class-D Design Ltd is selling its own brand of pro-audio loudspeakers to end users and installation companies. The company has been trading for seven years and is now moving into the pro amplifier market.

This is a market that has been dominated by Far Eastern imports. These use bipolar transistors and in some cases switching MOSFETS. These can be unreliable due to thermal control issues and this problem is sometimes exacerbated by sub-standard copied components.

Class-D is introducing a range of lateral MOSFET amplifiers. These use their own proprietary ALFET devices. Class-D is the only manufacturer of stable oscillation-free double-die plastic lateral MOSFETS in the world. These are UK made, of a guaranteed quality and do not suffer from thermal issues. As such, these highly reliable amplifiers are available at competitive costs, with superior quality and reliability.

In addition, Class-D manufacture their own zero voltage switching control chips using Class-D proprietary silicon, again manufactured in the UK and specifically aimed at the audio and lighting markets. They offer full research, design and development facilities.

The range comprises amplifier kits for DIY enthusiasts, 200W to 2000W RMS, amplifier modules up to 3000W RMS, active speakers, complete amplifiers, power supplies, energy-saving lighting products and bespoke designs for OEM and custom manufacturers. The THD figures are better than 0.005% and noise floors better than 110dBs.

For further information phone 01623 654080 or mobile 07980 600373, or browse www.class-d.com.

12GHz USB sampling oscilloscope

Pico Technology has unveiled the PicoScope 9201, a dual-channel PC sampling oscilloscope with a bandwidth of 12GHz that redefines the performance of sampling oscilloscopes at this price level.

The dual-channel PicoScope 9201 uses sequential equivalent-time sampling to achieve a sampling rate of 5TS/s. The wide bandwidth allows acquisition and measurement of fast signals with a transient response of 50ps or faster. Timebase

stability, accuracy, and a sampling interval of 200fs allow timing characterisation of jitter in the most demanding applications. The ability to trigger on high frequencies up to 10GHz allows measurements on microwave components with extremely fast data rates.

The PicoScope 9201 is available from local distributors, or direct from Pico Technology at www.picotech.com, for £5,995 + VAT and delivery.

NEW SERIAL EEPROM

Microchip has announced a serial EEPROM family using a new single I/O bus. Key facts:

- UN I/OTM single I/O bus interface
- 1Kbit to 16Kbit memory size in 3-pin SOT-23 package
- 1.8V operation; 10kHz to 100kHz data rate; advanced reliability features

The devices are based on Microchip's patent-pending UN I/OTM memory device protocol. The 11XX010, 11XX020, 11XX040, 11XX080 and 11XX160 are the first single I/O EEPROM devices that can support data rates from 10kHz to 100kHz, and the only 1, 2, 4, 8 and 16 Kbit EEPROMs available in a 3-pin SOT-23 package (in addition to other higher pin count packages).

The UNI/O bus and EEPROM devices were developed in response to market trends toward smaller consumer-electronic products with more features and functionality. With this new bus, only one

I/O pin is needed for communication between the EEPROM device and the microcontroller. Evaluation is simplified because the UNI/O memory devices are available in 8-pin packages.

The memory devices are supported by the new MPLAB Starter Kit for Serial Memory Products (Part number DV243003), the MPLAB PM3 Universal Device Programmer (Part number DV007004) and by software drivers available for Microchip's PIC MCUs at www.microchip.com.

The new devices are offered in two versions: the 11 LCXX0 versions operate from 2.5V to 5.5V, and the 11AAXX0 versions operate from 1.8V to 5.5V. All of the new memory devices are available in 3-pin SOT-23 as well as 8-pin PDIP, MSOP, SOIC and 2x3mm TDFN packages.

Samples of the 16Kbit 11XX160 EEPROM devices are available at sample.microchip.com.

For further information visit Microchip's website at www.microchip.com/unio.

By JIM ROWE



Four-channel A/V Selector

Do you have to swap audio/video (A-V) cables at the back of your TV set each time you want to switch between your DVD player, VCR, set-top box and camcorder? If so, this project will solve that problem. It lets you select any one of four S-video or composite video sources and also switches the accompanying stereo audio or bitstream digital audio.

THERE ARE PLENTY of audio-video (A-V) source selectors available off-the-shelf, but here's a low-cost unit that you can build yourself. It's easy to assemble and you will no longer have to muck about swapping A-V cables each time you want to change the video source.

The unit provides 4-channel switching for both S-video and composite video sources, but why not provide for component video and RGB as well? And why didn't we allow for switching 5.1-channel or even 7.1-channel audio, instead of

settling for just stereo/Pro Logic or digital bitstream audio?

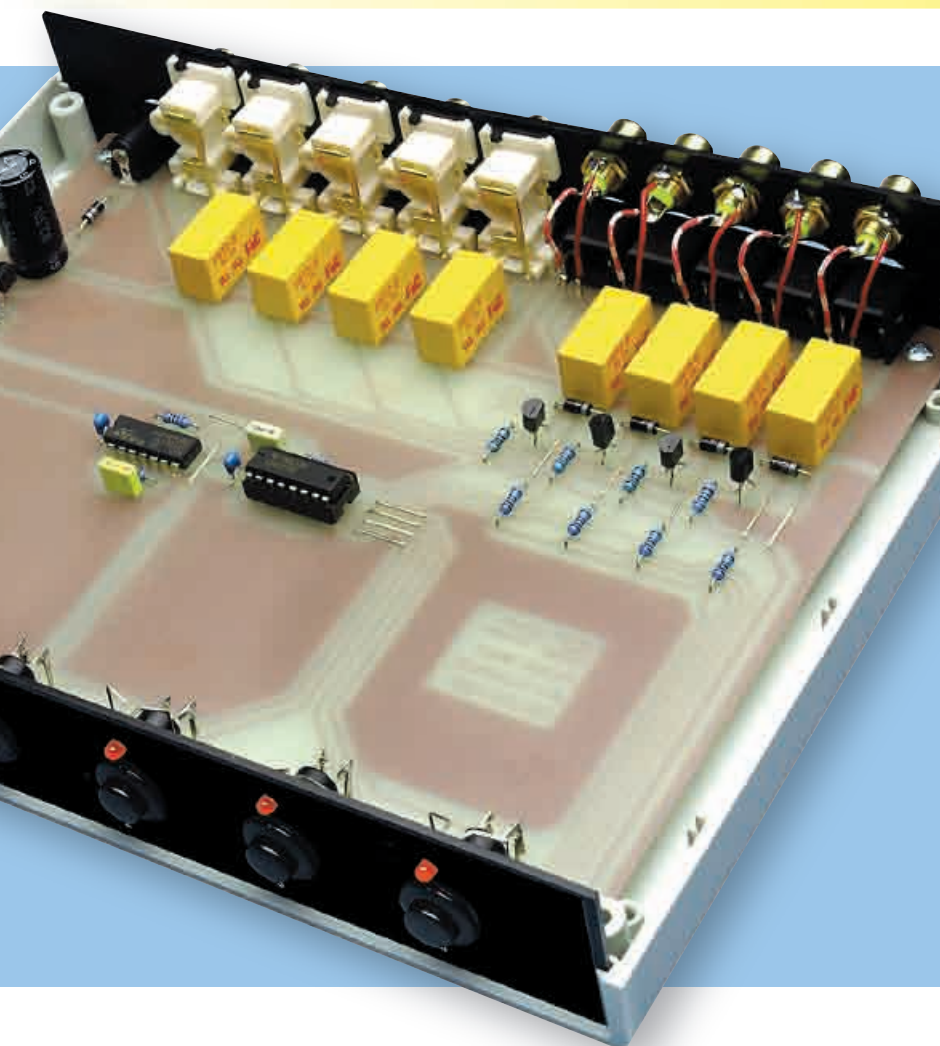
There's a simple one-word answer to these questions: *cost*. If we had provided those extra options, the circuit complexity would have grown significantly and the parts to build the selector would probably have cost you £75 or more, instead of the £25 or so that this unit will cost.

In short, there had to be a compromise between providing all of the features anyone might want and making it attractive to as many people as possible.

During the design phase, we did give consideration to providing for component video/RGB switching. However, this would have required at least four extra relays, five extra video connectors and a larger and more expensive box to house the circuit. So, considering that most of the wide-screen TVs and plasma panel screens which accept component video also have at least two input ports, we decided to draw the line at S-video and composite video switching.

Audio switching

Similarly, we decided not to worry about switching 5.1- or 7.1-channel analogue audio, because in most cases these multiple channels must be decoded from Dolby Digital/AC-3 or DTS digital surround signals – and these are provided in the latter form by most DVD players, set-top boxes and so on. Since digital decoders are mostly built into surround-sound amplifiers anyway (and are usually better than the decoders built into DVD players), there's no real need to select the decoded and separated



analogue audio signals. It's far simpler and more efficient to select the digital bitstream signals instead.

In fact, we believe this compromise approach has provided a selector unit that will serve the needs of the vast majority of people.

How it works

Our Four-channel A-V Selector is really very simple. Essentially, it's just a set of four 4-pole switches, with two poles switching the video for each channel and the other two the audio.

The only reason we're not actually using a 4-pole, 4-position mechanical switch is that they're no longer readily available. Instead, we're using eight mini DPDT relays – four to switch the video signals and four to switch the audio. These relays are driven by separate driver circuits, in turn controlled by a one-of-four selector circuit.

The circuit diagram for the Four-Channel A-V Selector is shown in Fig.1. The signal switching circuitry is at upper left and uses one relay to switch the two audio channels for each A-V source and a second relay to switch

the video signal (ie, Y and C for S-video or the single composite video signal). In this case, relays 1 and 5 switch the signals for Source 1, while relays 4 and 8 switch the signals for Source 4.

The remaining four relays (for Sources 2 and 3) are identically configured, but have been omitted from the circuit diagram for clarity.

The coils for each pair of relays are connected in parallel and driven together by 2N7000 MOSFETs (Q1 to Q4). However, only Q1 and Q4 are shown on the schematic, again for clarity.

The rest of the circuit performs the one-of-four selection. It's based on just two low-cost CMOS ICs: a 4093B quad Schmitt NAND gate (IC1) and a 4017B decade counter (IC2).

IC1a is connected as a free-running relaxation oscillator, operating at about 20kHz. Its output pulses, at pin 3, are fed to one of the clock inputs (CP0, pin 14) of IC2 via gates IC1b and IC1d, the latter connected as an inverter. This means that the clock pulses from IC1a cannot reach the clock input of IC2 unless pin 5 of IC1b is pulled high (ie, to 'open the gate').

Normally, however, this pin is held low by pin 10 of IC1c, as this gate has both of its inputs pulled high – one directly and the other via a 10k Ω resistor. As a result, when power is first applied to the circuit, IC1a begins oscillating but none of its pulses can reach IC2 to start the counter. Instead, IC2 is merely reset by the 100nF capacitor and 10k Ω resistor connected to its MR input (pin 15) and then just sits in this state.

This in turn means that the only output of IC2 which is at a logic high is its O0 output (pin 3) and so all the relay driver circuits are off.

Now consider what happens when one of the four selector pushbuttons (S1 to S4) is pressed. Because IC2's outputs O1 to O4 are all initially low, pressing any one of these buttons results in pin 9 of IC1c being pulled low as well. As a result, pin 10 of IC1c switches high and pulls pin 5 of IC1b high.

IC1b now allows clock pulses from IC1a to pass through to IC2 via IC1d, which means that IC2 immediately begins counting. But it only does so until the output connected to the pressed pushbutton goes high. As soon as this happens, pin 9 of IC1c switches high and its output switches low, thus pulling pin 5 of IC1b low again and preventing any further clock pulses from reaching IC2.

Specification

Video inputs: four channels (four S-video sockets and four RCA phono composite video sockets).

Audio inputs: four left and right channels (via RCA phono sockets).

Outputs: one video channel (S-video and RCA phono connectors) plus left and right audio channels (RCA phono connectors).

Switching: via relays, with selection via front panel pushbutton switches and LED indicators

Power Supply: 12V DC plugpack (rated at 150mA or more).

Parts List

- 1 PC board, code 676, available from the *EPE PCB Service*, size 198 x 157mm
- 1 low-profile ABS instrument case, size 225 x 165 x 40mm
- 5 double RCA phono sockets, PC-mount
- 5 mini 4-pin DIN sockets, 90° PC-mount
- 5 panel-mounting RCA phono sockets, yellow
- 1 2.5mm concentric DC power socket, PC-mount
- 4 SPST pushbutton switches
- 8 mini (DIL) 12V DPDT relays
- 10 6G x 6mm-long self-tapping screws
- 8 PC board terminal pins, 1mm diameter
- 1 12V 150mA DC plugpack

Semiconductors

- 1 4093B quad Schmitt NAND (IC1)
- 1 4017B decade counter (IC2)
- 1 78L05 5V regulator (REG1)
- 4 2N7000 MOSFETs (Q1-Q4)
- 4 3mm red LED (LED1-LED4)
- 1 3mm green LED (LED5)
- 5 1N4004 400V 1A diodes (D1-D5)

Capacitors

- 1 2200µF 25V RB electrolytic
- 1 10µF 16V RB electrolytic
- 2 100nF multilayer monolithic
- 1 100nF MKT polyester
- 1 4.7nF MKT polyester

Resistors (0.25W 1%)

- 1 22kΩ 1 390Ω
- 2 10kΩ 4 100Ω
- 4 1kΩ

As a result, IC2 stops with its O1, O2, O3 or O4 output high (depending on which button was pressed). This high output turns on its associated relay driver transistor, thus activating the relays for that channel and feeding the selected A-V signals through to the output sockets.

Of course, this same process is repeated if any of the other buttons is pressed. In which case, IC2 is simply re-activated and counts clock pulses until the output connected to the newly pressed button switches high. IC2 then stops again, with that output now effectively latched high instead of the previously selected output.

This counting process happens so quickly that, from the user's point of view, the new A-V source is selected as soon as its button is pressed. And because of the latching action, the chosen input source remains selected as long as the circuit is supplied with power or until one of the other selection buttons is pressed.

Diodes D1 to D4 across the relay coils are there to protect transistors Q1 to Q4 from transient back-EMF spikes when the relays switch off. In addition, a red LED and a 1kΩ series current-limiting resistor are connected across each pair of relay coils, to indicate which channel has been selected.

Power source

That's just about all there is to it – apart from the power supply. Power comes from a 12V DC 150mA plug-pack, with diode D5 providing reverse polarity protection. The resulting +12V DC rail is filtered using a 2200µF capacitor and powers the relays and the indicator LEDs.

The +12V DC rail also feeds voltage regulator REG1, which provides a +5V rail to power IC1 and IC2. This line also powers LED5 via a 390Ω current-limiting resistor, to provide power indication.

Construction

A single-sided PC board measuring 198 x 157mm (*EPE* code 676) accommodates most of the circuitry. This fits snugly inside a standard low profile plastic instrument box measuring 225 x 165 x 40mm, with all of the audio, video and power connectors accessed from the rear panel. The selector buttons and LEDs are mounted on the front panel.

The component layout and wiring details are as shown in Fig.2. Begin construction by fitting the 11 wire links, then fit the five dual RCA phono sockets (CON6 to CON10) to the rear of the board. Make sure that these socket assemblies are pushed all the way down onto the board and that their plastic locating spigots go through their matching holes before soldering the pins.

Follow these with the DC input connector (CON11) and the five mini-DIN connectors (CON1 to CON5). Once again, make sure that these connectors are all properly seated before soldering them.

The next step is to fit eight PC board terminal pins, which are later used to terminate LEDs 1 to 4. These pins

go along the front of the board, in the positions marked A and K on Fig.2 (ie, on either side of each pushbutton switch).

That done, cut four 25mm lengths of tinned copper wire and bend each one into a U-shape, with the arms about 5mm apart. These should then all be fitted in the positions shown for the connections to switches S1 to S4. Solder their ends to the pads underneath, then cut each U-shaped loop at its top centre and straighten the ends, to form a pair of wires ready to connect to the switch lugs.

Next, cut five 35mm lengths of yellow hookup wire and another five 35mm lengths of black hookup wire and remove 4mm of insulation from both ends of each piece. That done, solder one end of each of these wires to the PC board, as shown in Fig.2 – these are later used to connect the composite video connectors (CON12 to CON16) to the PC board.

The eight mini DIL relays are next on the list, followed by the 12 resistors, the two 100nF multilayer monolithic capacitors (small and usually blue) and the two MKT polyester capacitors. These parts are all non-polarised, so they can be fitted either way around.

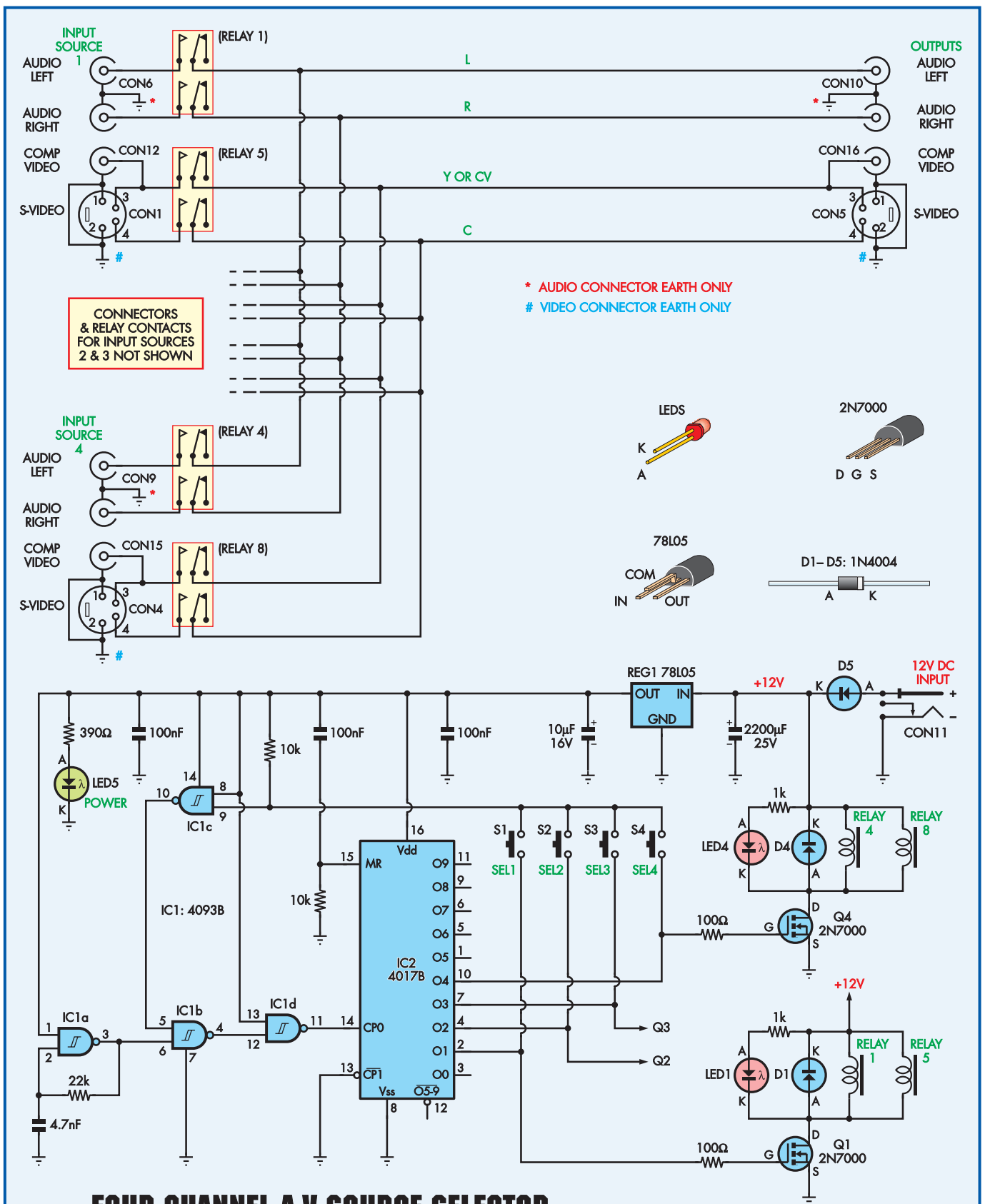
By contrast, the 2200µF and 10µF electrolytics are polarised, so be sure they go in the right way around. Fit these now, then install diodes D1-D5, again making sure they are correctly orientated. Diodes D1 to D5 have their cathodes (K) indicated by a band on their body. The LEDs have a flat on their package against the cathode lead; also the anode (A) lead is longer.

Final board assembly

The PC board assembly can now be completed by installing the 78L05 regulator (REG1), transistors Q1 to Q4, the two ICs and LED5. MOSFETs Q1 to Q4 and REG1 all come in 3-pin TO-92 packages and must be orientated as shown (don't get them mixed up). Similarly, the two ICs (both CMOS devices) must be correctly orientated.

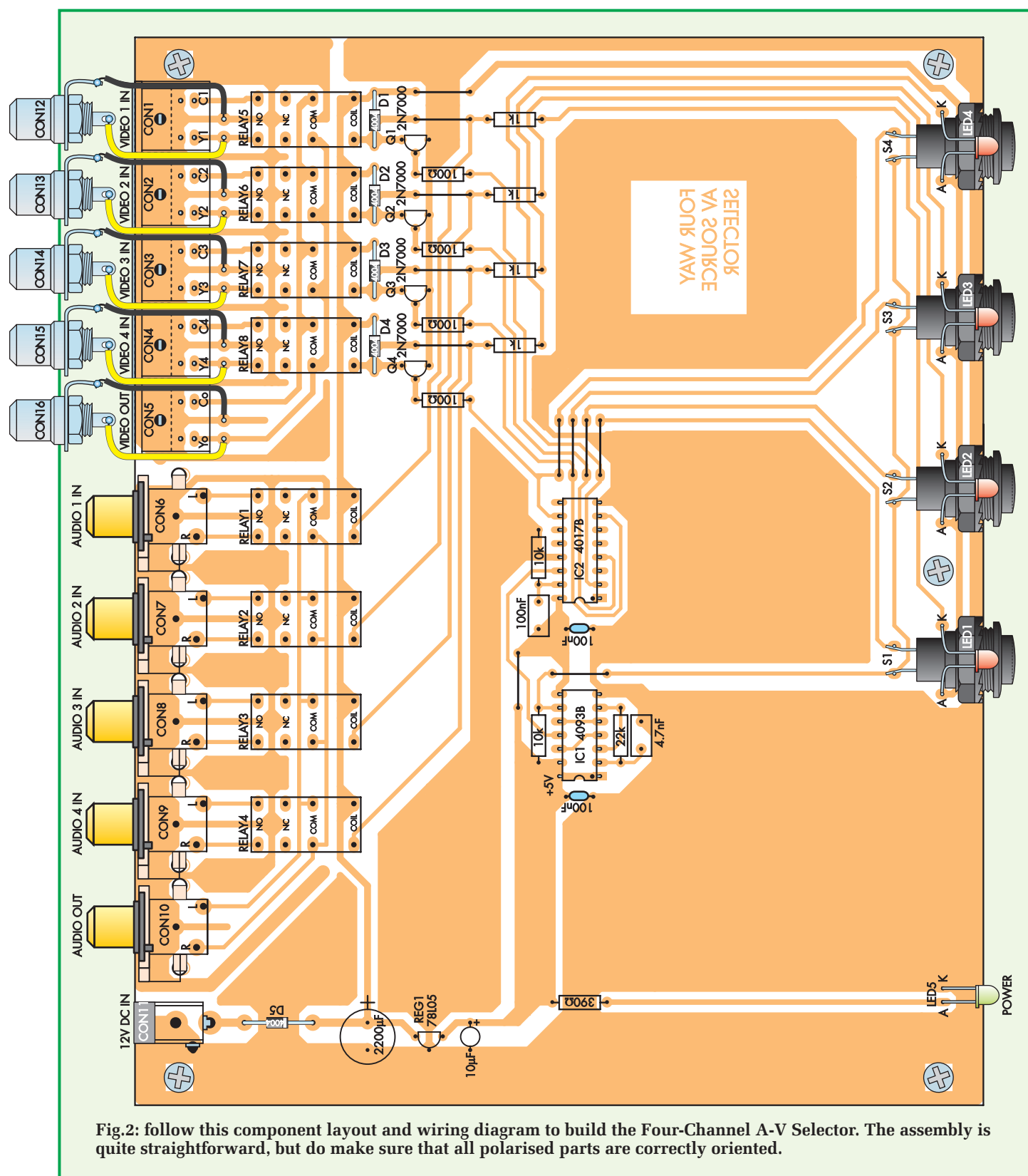
Be sure to observe the usual precautions when handling the CMOS devices – ie, use an earthed soldering iron, make sure you're not carrying a charge yourself, avoid touching the pins and solder the supply pins to the board first (pins 7 and 14 for IC1 and pins 8 and 16 for IC2).

The green LED (LED5) is fitted to the board at full lead length, with its longer



FOUR CHANNEL A-V SOURCE SELECTOR

Fig.1: the circuit uses eight mini DPDT relays – four to switch the video signals and four to switch the audio. These relays are driven by MOSFETs Q1 to Q4, which are in turn controlled by a one-of-four selector circuit based on quad Schmitt NAND gate IC1 and decade counter IC2.

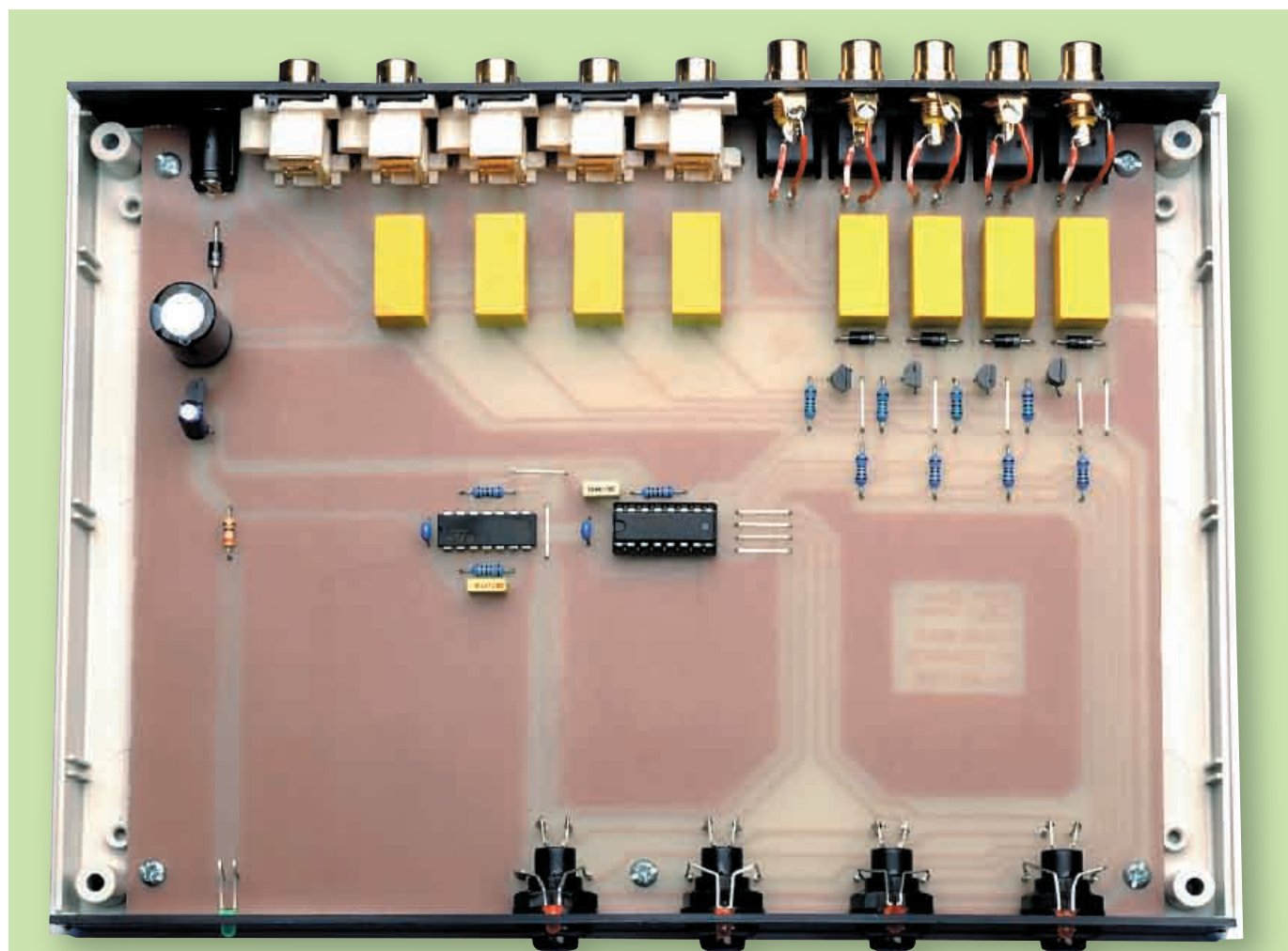


anode (A) lead to the left. Once it's in, bend both leads forwards by 90° about 10mm above the board. This will position the LED so that it will protrude through a matching hole in the front panel.

Casing up

The drilling details and dimensions for the specified low-profile case is indicated in Fig.3. Use the front and rear panel artworks as drilling templates

(or use the drilling diagrams). Just attach copies of the artworks to the panels and drill and ream the holes to suit. These panels are reproduced here full-size.



This is the view inside the completed prototype. All parts, except for connectors CON12 to CON16, switches S1 to S4 and the four indicator LEDs, are mounted directly on the PC board.

Once the panels have been drilled, you can prepare the labels by glueing the artworks onto adhesive-backed A4 label paper. The stickers can then be covered with clear packaging tape to protect them, before cutting to size.

After that, you just peel off the backing tape, carefully affix each one to its panel and cut out the holes using a sharp hobby knife.

The next step is to cut away the three moulded PC board support pillars in the bottom half of the case, near the centre of the rear edge. This is necessary so that they don't interfere with the solder joints on the connector pins. The plastic is quite soft and it's easy to cut away the redundant pillars with a pair of sharp side cutters.

That done, fit the rear panel over the dual RCA phono connectors on

the PC board and lower the assembly into the case. The PC board can then be secured to the base of the case using five 6mm-long self-tapping screws, which go into the integral mounting pillars – see Fig.2.

Now use the remaining five 6mm self-tapping screws to fasten the rear panel to the five dual RCA phono sockets (CON6 to CON10). These screws go through the panel and

Table 1: Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
□	1	22kΩ	red red orange brown	red red black red brown
□	2	10kΩ	brown black orange brown	brown black black red brown
□	4	1kΩ	brown black red brown	brown black black brown brown
□	1	390Ω	orange white brown brown	orange white black black brown
□	4	100Ω	brown black brown brown	brown black black black brown

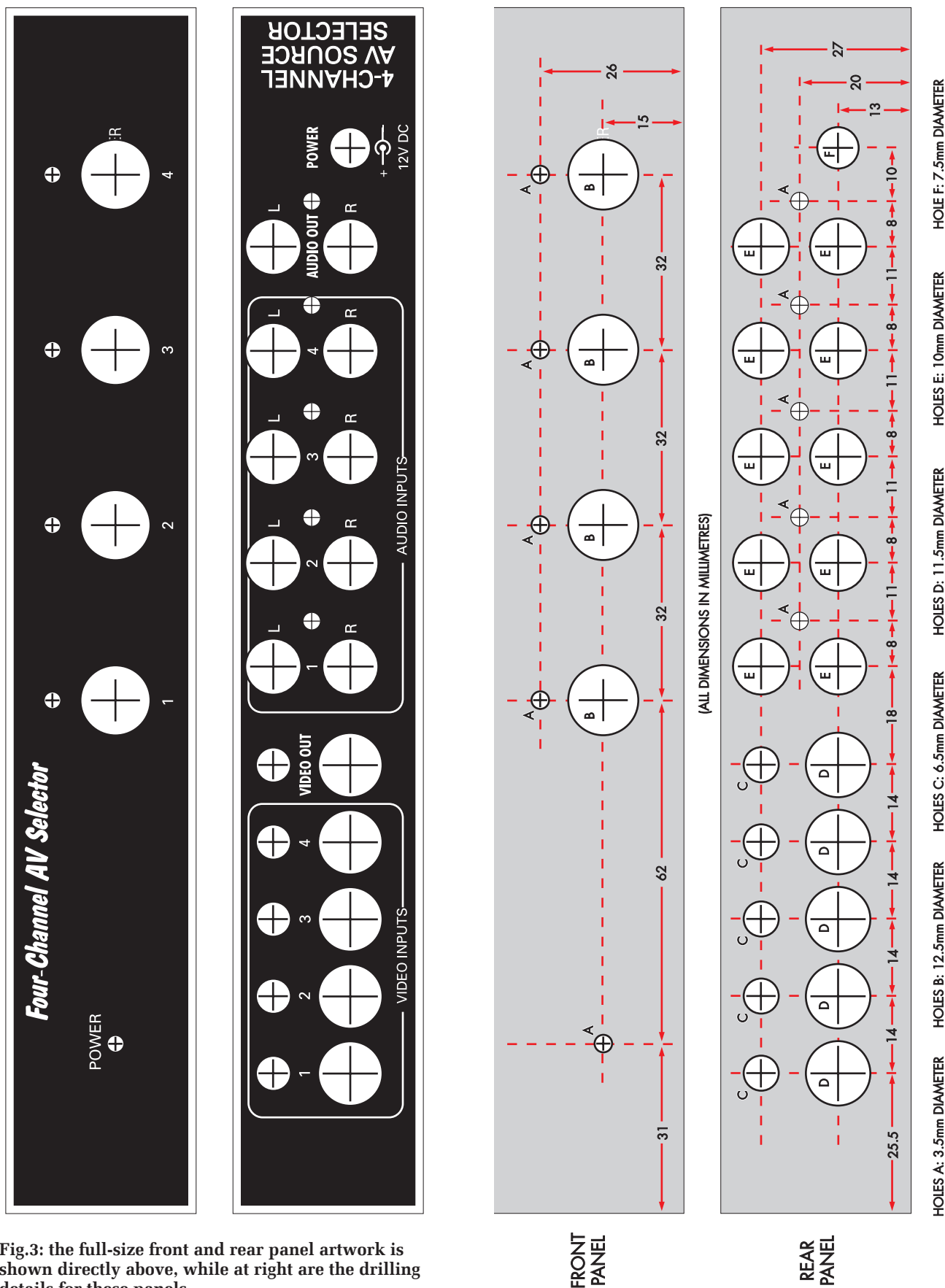
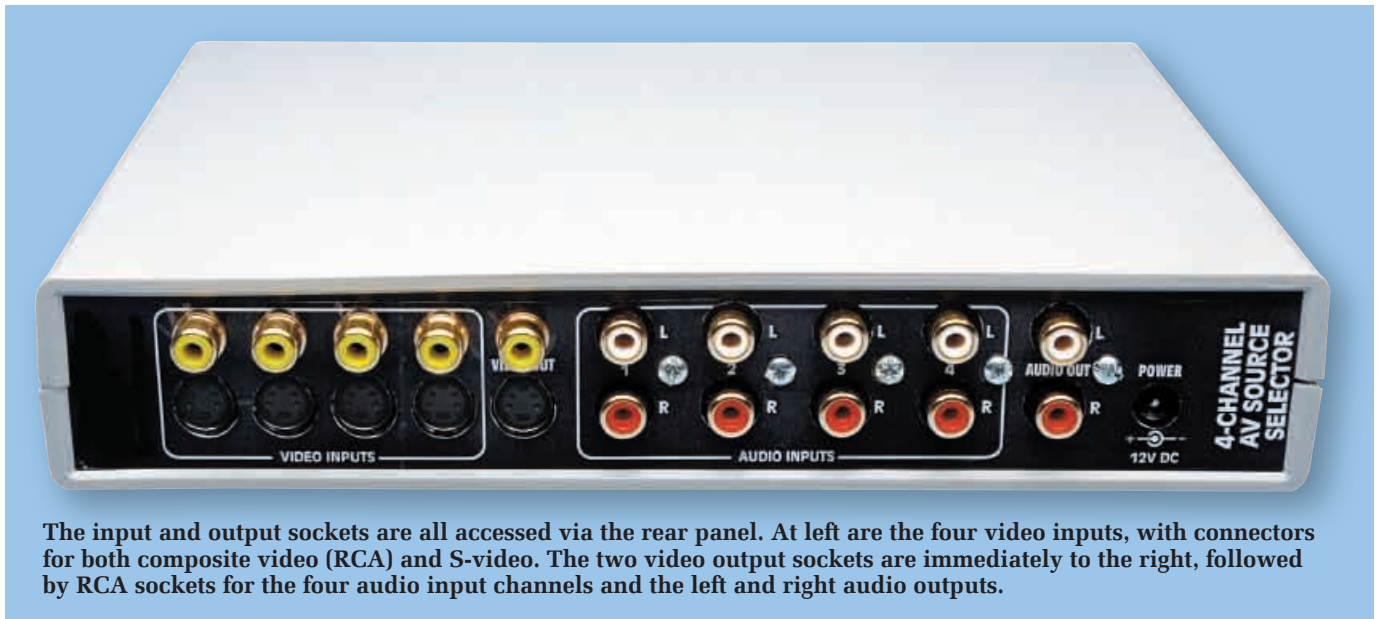


Fig.3: the full-size front and rear panel artwork is shown directly above, while at right are the drilling details for these panels.



The input and output sockets are all accessed via the rear panel. At left are the four video inputs, with connectors for both composite video (RCA) and S-video. The two video output sockets are immediately to the right, followed by RCA sockets for the four audio input channels and the left and right audio outputs.

into matching holes in the connector bodies, so the operation is quite straightforward. The five single RCA sockets (CON1 to CON5) can then be fitted to the panel (above the mini-DIN sockets), with the supplied earthing solder lugs under the nuts and oriented upwards.

Tighten each nut using a small spanner or pliers, then bend the free part of the lug forwards by about 75°. Finally, solder the yellow wires to the centre terminals of the sockets and the black wires to the earth lugs.

Front panel

The front panel assembly is even easier – just mount the four push-button switches (S1 to S4) but don't over-tighten the large plastic nuts provided, as it's easy to strip their threads if too much force is applied. Note that each switch should be positioned so that its terminals are aligned horizontally, for easy connection of the wires from the PC board.

That done, lower the front panel into its slot in the bottom of the box and solder the switch leads to their matching wires. *A word of warning here:* make each solder joint as quickly as possible, so that you don't overheat the switch or risk melting the solder at the lower end of each wire.

Finally, push the green power LED (LED5) through its matching hole and install the four channel indicator LEDs (LEDs 1 to 4). The latter are simply

pushed through their respective front panel holes and their leads soldered to the PC stakes.

It's a good idea to bend each LED's leads to its approximate shape before trying to fit the LED in position. You do this by first bending the leads outwards by 70° about 8mm from the back of the LED body, then bending them downwards by 90° about 6mm out from the first bends (see photo).

Be sure to install them the right way around – the longer anode lead goes to the left PC stake in each case (see Fig.2).

The soldered connections should be sufficient to hold the LEDs in place. However, you may also want to apply a small 'dab' of epoxy cement to the rear of each LED, to make them a little more secure.

Your Four-Channel A-V Selector is now complete and ready for testing.

Testing

There are no setting-up adjustments to be made, so the test procedure is easy. All you need to do is apply power to CON11, using a 12V DC plugpack (or battery), and check that the unit functions correctly.

First, check that the green power LED immediately lights when power is applied. If it does, press one of the pushbuttons. The red LED above that button should immediately light and you should hear a faint 'click' as the two relays for that channel are activated.

Now press one of the other buttons. Its LED should now light instead and there should be another faint click as that channel's relays activate and the previously activated relays switch off.

Finally, press the remaining two buttons in turn and check that you get the same response. If so, your 4-Channel A-V Selector is working correctly and you can now secure the top half of the case to the bottom using the four M3 × 25mm countersink head screws provided.

Troubleshooting

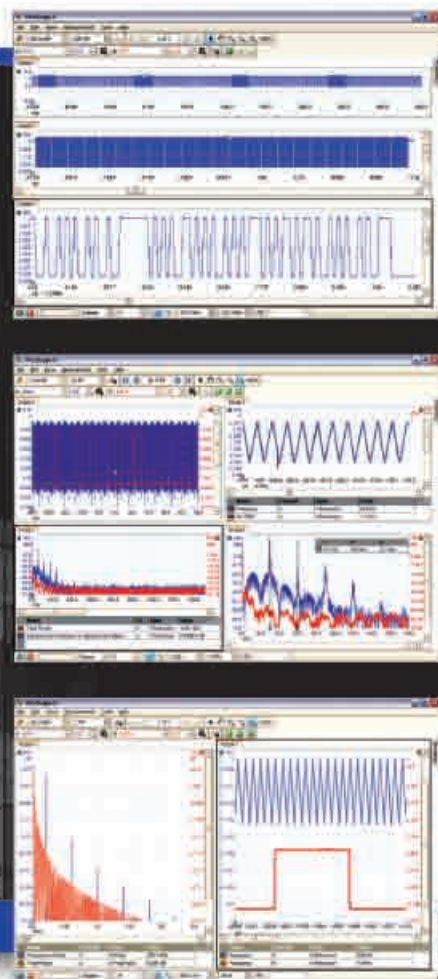
There's not much in this circuit, so there's very little to go wrong. However, in the unlikely event that problems do occur, they're most likely to be caused by fitting polarised parts the wrong way around.

If the whole project is 'dead', the odds are that you've either fitted diode D5 the wrong way around or swapped the connections to the 2.5mm plug on the 12V power lead from the plugpack or battery. Similarly, if the circuit seems to work correctly but one of the five LEDs doesn't light when it should, its leads have probably been transposed.

These are almost the only things that could be wrong, apart from poorly made solder joints or even joints you've forgotten to make! **EPE**

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Up close and personal

TechnoTalk

Mark Nelson

PANs and NFC – do you need to know about these new expressions? Will they change your ‘personal’ life? Mark Nelson thinks so and is determined to tell you all about them in any case.

THERE’S far too much alphabet soup on the menu these days and you too may be fed up with an excess of meaningless new acronyms. Of course some of them do catch on eventually, such as PIN and LED. Others fail to click, such as SMS (short messaging system, the original name for texting).

That’s enough philosophy, so let’s crack on with the subject or rather subjects in hand. Without NFC you cannot have PANs but perversely I’ll deal with PANs first.

PANs

Twenty years ago PANs were touted as the replacement for POTS, with POTS being the Plain Old Telephone Service. The PANs acronym in those days stood for the Positively Amazing Network services that British Telecom and other telcos were introducing, along with the new digital exchanges such as System X and System Y. Many of these new network-based services failed to catch on, but a few did, such as ‘ring back’ (calling you back when the engaged number you wanted becomes free), BT ‘callminder’ voicemail and the incredibly handy facility for finding out the number of the person who called you last (1471) and then ringing them back by pressing 3.

Back to the future, where PANs now stands for Personal Area Networks. In this case, personal does mean personal, as we are talking about communication networks that revolve entirely and exclusively around you! On this subject Wikipedia conveniently states:

A personal area network (PAN) is a computer network used for communication among computer devices (including telephones and personal digital assistants) close to one person. The devices may or may not belong to the person in question. The reach of a PAN is typically a few metres.

PANs can be used for communication among the personal devices themselves (intrapersonal communication), or for connecting to a higher level network and the Internet (an uplink). Personal area networks may be wired with computer buses such as USB and FireWire. A wireless personal area network (WPAN) can also be made possible with network technologies such as IrDA, Bluetooth, UWB, and ZigBee.

Wet string antennas

If I were revising Wikipedia I would change this entry to use the word ‘wirefree’ rather than ‘wireless’, since to most people wireless means radio and nothing else. For PANs, radio is not necessarily the best solution, considering the amount of ‘radio smog’ arising from cordless and cellular

phones plus wireless local area networks. As well as interference, there are security issues too. Among the non-radio alternatives there are infrared optics (OK, not very practical for communication devices kept in pockets and wallets!) and electrical field-sensing methods using the body as a ‘wet string’ antenna (described below).

PANs needn’t be confined to the home or office. The applications extend to your car, shopping malls, railway stations and airports. An in-car PAN could detect the presence of the user, thereby allowing the mobile handset to automatically acquire pertinent information for driving such as weather and road conditions. Other applications include mobile commerce, in which a user of a mobile device communicates with another machine for transactions, such as ticket purchase, vending and other small purchases.

We are now entering the realm of near-field communication (NFC), mentioned earlier, so we should examine the differences between near and far-field communication.

Far and near

In any kind of conventional wirefree communication our aim is to project the signal over a considerable distance, hence the term ‘far field’. In near-field communication it’s different. Big distances are not the target, so there’s no need to seek the ultimate in efficiency.

You maximise far-field transmission efficiency by matching the impedance of the transmitter to free space, using a carefully designed antenna. With near-field communication you can ‘swamp’ your own locality more simply, using very low frequencies, which are easier to generate. The field strength is low, posing less of a health risk and avoiding the need to consider licensing regulations.

Using the human body as an electrical transmission medium is a complex subject and difficult to summarise in a few sentences. In essence, however, communicating between two devices using the body as a medium involves the use of a PAN transmitter and a PAN receiver. The body-worn device is obviously battery operated and couples a small displacement current capacitively through the human body to the receiver. The transmitter itself need not be in direct contact with the skin, so long as the transmitter electrode is close to the body, allowing the skin to act as a capacitor. By modulating the electric current we can transfer data to the receiver with the earth acting as the return path.

Sounds scary? Perhaps, but it’s stated that the current used in PANs is one-billionth

of an amp (a nanoamp), less than the nerve currents that flow naturally through your body. A number of modulation and multiplexing systems are proposed and although prototype devices work at not more than 2.4kbit/s, significantly higher data rates are expected to be feasible.

Body talk

Who will be the early adopters of body PANs? It’s hard to tell while most devices are still experimental and expensive.

Medical applications for patients in hospital are a possibility, whereas performance monitoring systems for professional and semi-pro athletes already use this kind of technology. This fitness market could expand a great deal if a mass market enabled prices to fall. Jack Shandle of Wireless Net Designline argues that recreational runners and weekend cyclists might well wish to see at a glance how they had run or pedalled and how many calories they had burned.

Body PANs may not catch on, but contactless near-field communication is already a reality. If you live or work in London and have a ‘lobster card’, you’re using it every time you touch in and touch out on public transport. Some users are already using their cards to buy food, cigarettes and newspapers too.

Near-field communication could play a major enabling role in eliminating cash handling and speeding up payment using some kind of contactless communication device. The commercial potential — and convenience to you and me — is crystal clear. What’s less obvious is which particular device or object will ‘do the business’ and how.

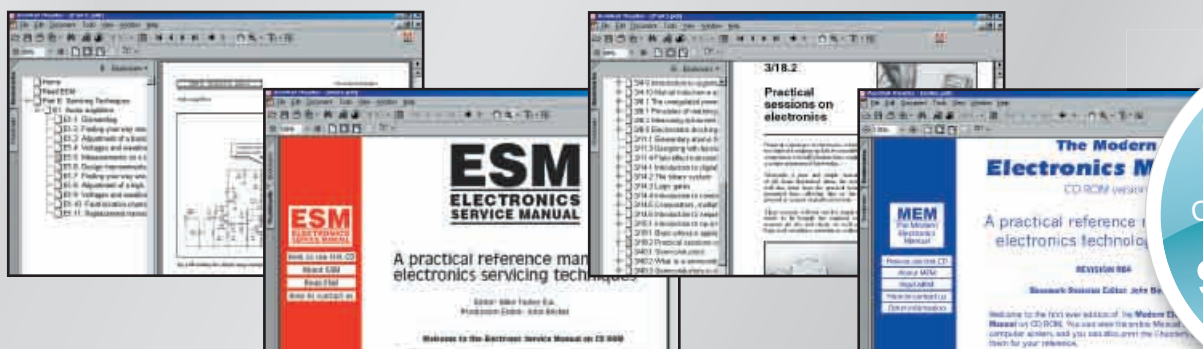
There’s no earthly reason why the debit payment device needs to have the same ‘form factor’ as a credit card. It could be your travel pass or a new kind of combined credit/debit card that doesn’t have to leave your pocket. On the other hand, the mechanism might involve an enhanced SIM card in your mobile phone or it might be incorporated into something that everyone carries, like a pen or comb.

The choice will certainly be contested, with a battle royal fought between the banks, mobile phone operators and third-party organisations (what about eBay for instance?), all of which have conflicting commercial interests. There are security and standardisation issues to be addressed too, as well as a way of building compatible transponders into point-of-sale terminals. The one thing that’s not in dispute is the technology behind near-field communication, which is fully capable of rising to the occasion. Watch this space!

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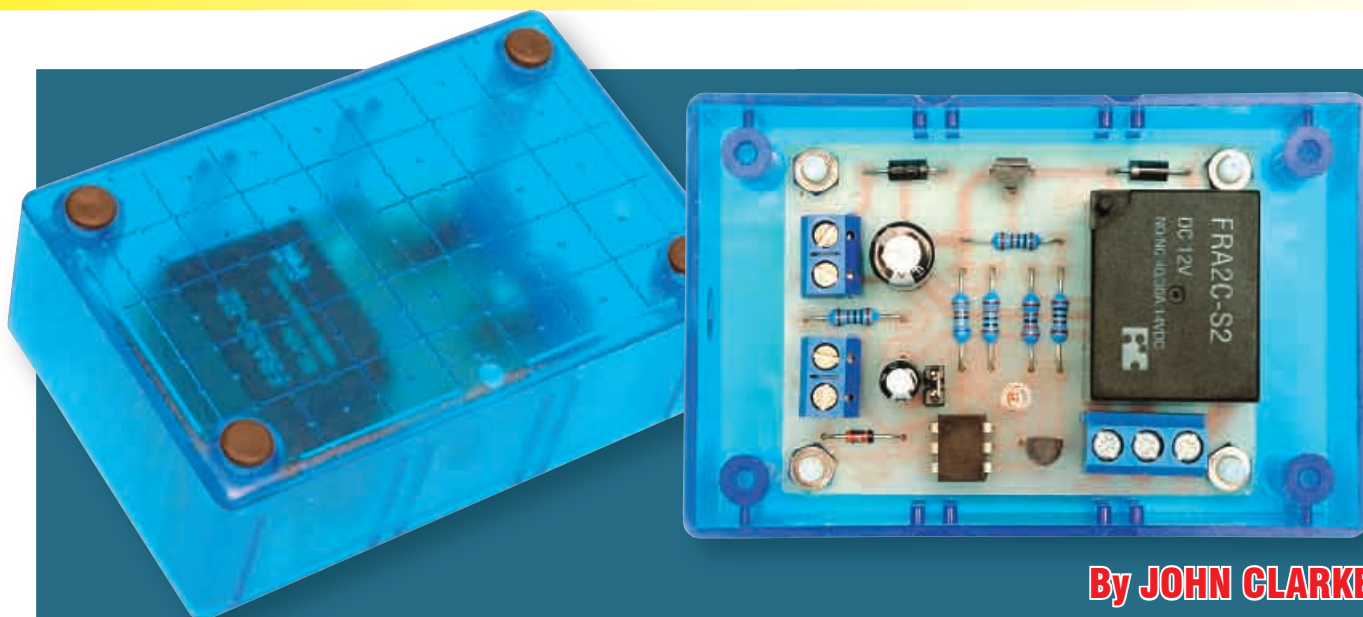
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By **JOHN CLARKE**

Control high-current loads with this DC Relay Switch

Want to switch power to a high-current load using a circuit capable of supplying just a few milliamps? No problem – build and use this low-cost DC Relay Switch.

IT'S OFTEN NECESSARY to switch power to a device that requires a current of several amps in order to drive it. The problem is, the device that's required to do the switching may only be capable of supplying just a few milliamps. Such a circuit might be capable of switching on an LED, but that's about all.

The way around this problem is to use a relay with heavy-duty contacts to switch the power. However, your electronic switching circuit may not even have sufficient power to drive a relay coil – at least not directly.

This DC Relay Switch board is the answer to that type of situation. It utilises a heavy-duty, automotive-type relay with

30A contacts, runs from a 12V supply and requires just 400 μ A of signal to trigger the relay. That's made possible by using an optocoupler and some simple electronic circuitry to drive the relay.

What's more, the input trigger signal does not have to be ground referenced. This means that you can drive the relay board from just about any DC signal, whether it normally sits at around 12V, 5V or 0V. It can even be driven by low-voltage AC or by a signal that is rapidly switching on and off.

Current drive

In practice, the DC Relay Switch requires a current to drive it rather than a voltage. A signal current of just 400 μ A or more switches the relay on, and when there is no current, the relay switches off.

In practice, this means that you can drive the relay switch board using an external circuit that normally drives an LED. When the LED is on, the relay is on, and *vice versa*. Alternatively, the relay board can be connected so that the relay is off when the external LED is lit.

If the LED is multiplexed (ie, switched on and off) at a fast rate, then the relay board can be configured to switch on the relay whenever the LED is being driven by the switching circuit. An LED on the DC Relay Switch board

Main features

- Automotive-style high-current relay
- Operates from 12V DC power supply
- Suitable for low-voltage switching only (up to 50V DC)
- Activated by low current
- Isolated input to provide flexible switching options
- Can be activated using a low-voltage AC signal or an oscillating signal
- Relay-on LED indication
- Normally open (NO) and normally closed (NC) relay output terminals

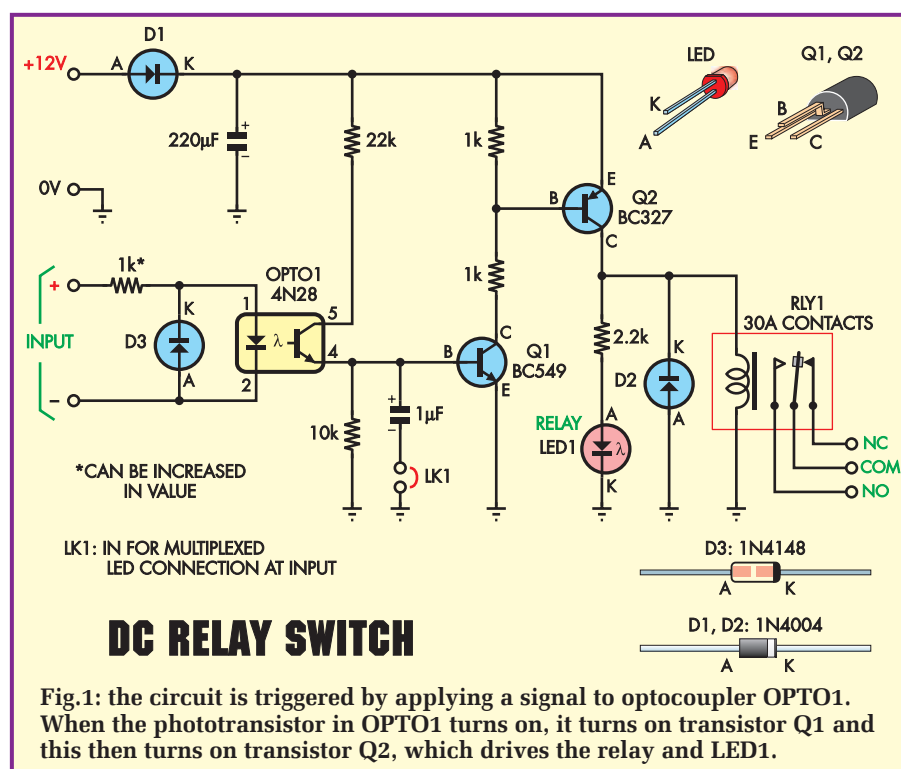


Fig.1: the circuit is triggered by applying a signal to optocoupler OPTO1. When the phototransistor in OPTO1 turns on, it turns on transistor Q1 and this then turns on transistor Q2, which drives the relay and LED1.

provides on/off indication for the relay (ie, it lights when the relay switches on and goes off when the relay is off).

As shown in the photographs, the DC Relay Switch comprises a small PC board that includes the relay, the optoisolator, two transistors and various other minor components. It is powered from a 12V DC supply via an on-board screw terminal block. A second 2-way screw terminal block is used for the trigger signal inputs.

External connections to the relay contacts can be made using either PC-mount spade connectors or a 3-way screw terminal block. The spade connectors are best for high-current applications.

Finally, the PC board can be fitted inside a small plastic (UB5) case, if this is required.

How it works

OK, let's see how the circuit works
– examine Fig.1.

As shown, the input trigger signal is applied to the LED inside optocoupler OPTO1 via a $1k\Omega$ resistor. This resistor limits the LED current to less than 12mA for a 12V signal and to less than 5mA for a 5V signal.

Diode D3 prevents the LED inside OPTO1 from breaking down and dissipating too much power if a reverse voltage is applied. In this case, D3 conducts and limits the voltage across the LED to a safe value (ie, to about 0.6V).

When current flows in the optocoupler LED, the optotransistor conducts and supplies base current to transistor Q1 via the 22k Ω resistor from the 12V supply rail. This switches Q1 on, which in turn switches Q2 on via its associated 1k Ω base resistor. When Q2 switches on, relay RLY1 also switches on, as does LED1.

The 10k Ω resistor between Q1's base and ground (0V) ensures that Q1 switches off when the phototransistor in OPTO1 turns off. Similarly, the 1k Ω resistor between Q2's base and emitter ensures that this transistor switches off when Q1 switches off.

The 1 μ F capacitor on Q1's base is necessary if the input is driven using an AC signal or some other switching signal. This capacitor is connected into circuit using link LK1 and filters the resulting signal on pin 4 of OPTO1 to produce a steady DC voltage. This ensures that Q1 remains on whenever the input signal is applied.

Note that LK1 is only necessary for AC input signals. It can be left out of

the circuit (ie, the $1\mu\text{F}$ capacitor is disconnected) for DC trigger signals.

Diode D2 provides spike protection for transistor Q2 when the relay is switched off. It shunts the back-EMF voltage spike generated when the relay switches off – a necessary precaution to prevent ‘punch-through’ of the transistor.

Power for the circuit can be derived from any suitable 12V DC supply (eg, a plugpack or batteries). Diode D1 provides reverse polarity protection, while a 220 μ F capacitor decouples the supply.

- 1 PC board, code 677, available from the *EPE PCB Service*, size 46 x 61mm
- 1 plastic (UB5) box, size 83 x 54 x 31mm
- 1 SPDT 12V 30A PC mount horn relay or equivalent (RLY1)
- 2 2-way screw terminal connectors (5.08mm pin spacing)
- 1 3-way screw terminal connectors (5.08mm pin spacing)
- 3 PC mount 6.4mm spade connectors
- 1 2-way pin header (2.54mm pin spacing) (LK1)
- 1 jumper shunt for LK1
- 4 M3 x 12mm countersunk nylon screws and nuts
- 4 M3 nylon washers

Semiconductors

- 1 4N28 optocoupler (OPTO1)
- 1 BC549 NPN transistor (Q1)
- 1 BC327 PNP transistor (Q2)
- 2 1N4004 1A diodes (D1,D2)
- 1 1N4148 diode (D3)
- 1 3mm red LED (LED1)

Capacitors

- 1 220 μ F 16V PC radial elect.
1 1 μ F 16V PC radial elect.

Resistors (0.25W, 1%)

- 1 22kΩ 1 2.2kΩ
1 10kΩ 3 1kΩ

Operating the circuit from 24V DC

Want to operate the DC Relay Switch from 24V DC? Here's how to do it:

- Use a 24V relay instead of a 12V relay – eg, 24V 30A relay
- Increase the voltage rating of all capacitors to 35V
- Change the 2.2k Ω resistor in series with LED1 to 4.7k Ω 0.25W

Constructional Project

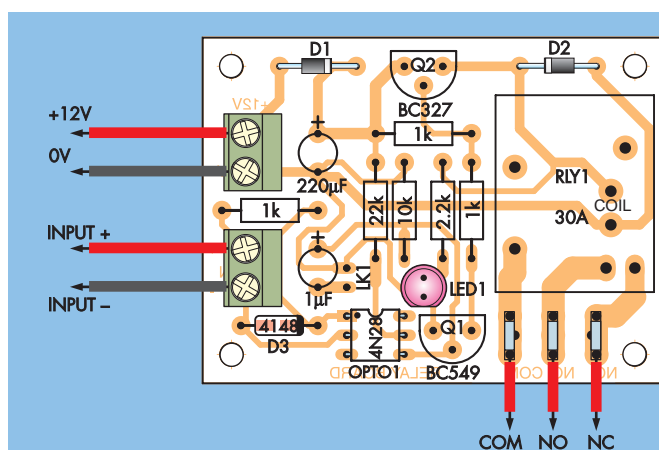
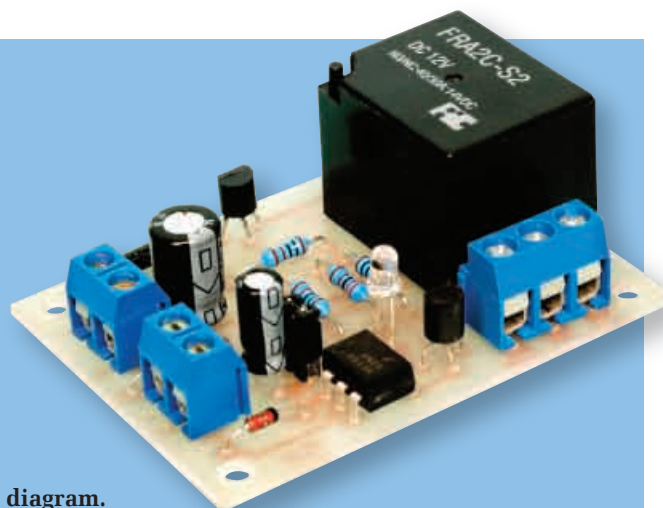


Fig.2: install the parts on the PC board as shown in this layout diagram. Be careful not to get transistors Q1 and Q2 mixed up – they may look identical but Q1 is a BC549 (NPN) while Q2 is a BC327 (PNP).



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Construction

The DC Relay Switch is built on a PC board (*EPE* code 677) measuring just 46 × 61mm. This board is available from the *EPE PCB Service*, see page 70. The board fits inside a small (83×54×31mm approx.) plastic box and is secured using four M3 × 12mm countersink *Nylon* screws and nuts. A 3mm Nylon washer is used between the PC board and the case at each mounting point, to lift the board clear of the base.

Fig.2 shows the component layout on the PC board. Begin construction by checking the PC board for any defects, such as broken copper tracks and shorts between adjacent tracks.

WARNING!

DO NOT use this DC Relay Switch to switch 230V AC mains voltages. The relay is not designed to do this and it is dangerous to connect mains to the bare PC board.

If you do need to switch mains voltages, then use this board to trigger an external mains-rated relay.

That done, check the corner hole sizes – these should all be 3mm in diameter. In addition, the holes for the relay pins and the screw terminal blocks must be large enough to accept these parts.

Once all the hole sizes are correct, begin the assembly by installing the resistors. Table 1 shows the resistor colour codes, but it's a good idea to check them using a digital multimeter – just to make sure.

Next, install the diodes and the optocoupler (OPTO1), making sure they go in with the correct polarity. Follow these with the capacitors, transistors Q1 and Q2, the LED and the relay. Again, take care with the polarity of these components.

Transistors Q1 and Q2 come in identical (TO-92) packages, so be careful not to get them mixed up. Transistor Q1 is an *NPN* BC549 type, while Q2 is a *PNP* BC327. The circuit won't work if you transpose them or install them the wrong way around.

As mentioned previously, you can use either a 3-way screw terminal connector or PC-mount spade connectors to make the external connections to the COM (pole), NO and NC relay contacts. Use the spade connectors if the relay terminals are to carry currents in excess of 2A.

Finally, install the 2-way pin header for link LK1. The link itself can be left out if you intend to trigger the board using a DC input signal. Alternatively, install the link if you want delayed switch-on and switch-off for the relay, or if you intend using an AC input signal (see below).

Testing

OK, now for the ‘smoke’ test. You will need a 12V DC supply rated at about 150mA to power the board. Connect this to the +12V and 0V terminals, making sure you get the polarity right.

Initially, when you apply power, nothing should happen. You can now check if the circuit works by connecting the negative (-) signal input to 0V and the positive (+) input to the +12V rail. When you do so, the relay should immediately switch on and the LED should light.

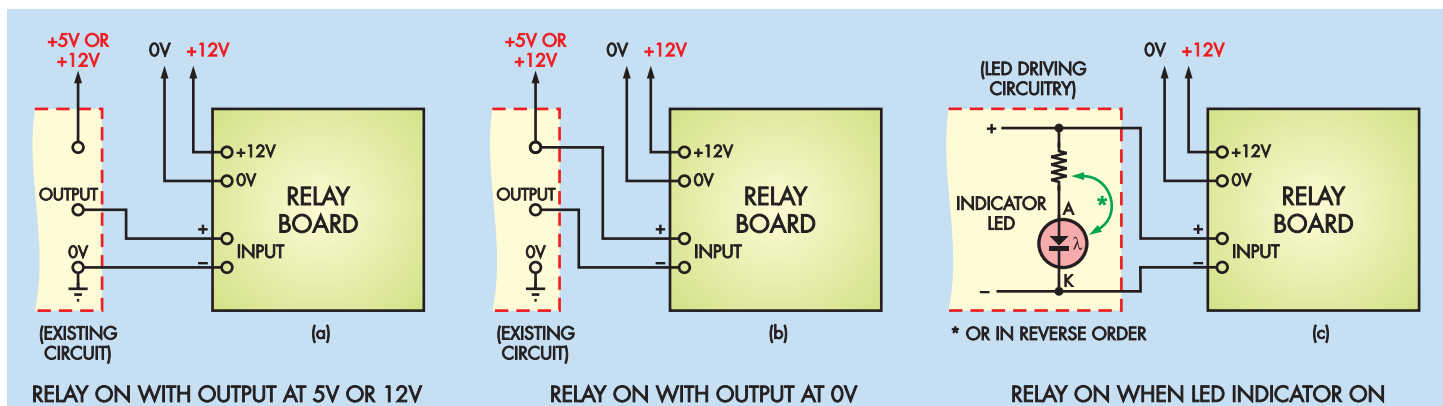
How to use it

Fig.3 shows three different circuit configurations that can be used to trigger the relay board.

Fig.3(a) shows how to turn the relay on using a signal output that goes high (ie, to 5V or 12V). Conversely, Fig.3(b) shows how to rearrange the wiring so that the relay turns on for a signal output that goes low (ie, to 0V).

Table 1: Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
<input type="checkbox"/>	1	22kΩ	red red orange brown	red red black red brown
<input type="checkbox"/>	1	10kΩ	brown black orange brown	brown black black red brown
<input type="checkbox"/>	1	2.2kΩ	red red red brown	red red black brown brown
<input type="checkbox"/>	3	1kΩ	brown black red brown	brown black black brown brown



RELAY ON WITH OUTPUT AT 5V OR 12V

RELAY ON WITH OUTPUT AT 0V

RELAY ON WHEN LED INDICATOR ON

Fig.3: the various triggering options. In (a) the relay board is triggered by a signal that goes from low to high (+5V or +12V); in (b) triggering is by a signal that goes to 0V; and in (c) by an external circuit that turns on an indicator LED.

Fig.3(c) shows how to drive the relay from a circuit that normally powers an LED. Note that if the LED is multiplexed when it is lit (ie, switched on and off at a fast rate), the relay will chatter on and off. Inserting link LK1 to connect the $1\mu\text{F}$ capacitor into circuit should stop this chattering.

In each of the three cases above, if you want delayed switch-on and switch-off for the relay, increase the value of the $1\mu\text{F}$ capacitor. A value

of $220\mu\text{F}$ will give a nominal 1-second delay.

It is important that the trigger circuit be capable of providing the required current to the relay board input. The relay board will draw about 3mA when there is 5V between its '+' and '-' inputs, and 10mA when there is 12V between these terminals.

If this exceeds what the trigger circuit can deliver, then the $1\text{k}\Omega$ resistor in series with pin 1 of the

optocoupler can be increased. Doubling this resistor (eg, to $2.0\text{k}\Omega$) will halve the current requirement, but if you make the resistor's value too high, then the optotransistor may not turn on sufficiently to drive the relay circuit.

The minimum recommended trigger current is $400\mu\text{A}$. This corresponds to using a $22\text{k}\Omega$ resistor in series with OPTO1 for a 12V power supply and a $7.5\text{k}\Omega$ resistor for a 5V supply. **EPE**

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INTERFACE

ACCESSING SERIAL PORTS

THIS month we continue with accessing the serial ports, which can be either the conventional or the USB variety, using Visual BASIC 6.0 or a more modern version such as Visual BASIC 2005 or 2008. None of the information provided here applies to Visual BASIC NET, which lacks the MSCOMM component of Visual BASIC 6.0, and does not have the SerialPort component of Visual BASIC 2005/8 either. It lacks any built-in support for serial ports, and it is necessary to upgrade to a more recent version in order to obtain this support.

Surprisingly perhaps, it is not possible to use MSCOMM with Visual BASIC NET, and trying to do so produces an error message stating that MSCOMM is not licensed for use with that version of Visual BASIC. This happens even if a suitable version of Visual BASIC 6.0 is installed on the computer.

MSCOMM

As pointed out in the previous *Interface* article, the MSCOMM and SerialPort components have many similarities, but they are not used identically. Despite supposed advances in this programming language, it is probably fair to say that Visual BASIC 6.0 still represents the best program for writing software for your own PC add-ons, and we will take a detailed look at serial communications with this program first.

MSCOMM is not installed as a standard component, so the first step is to go to the Project menu and select Components. In the new window that appears, tick the checkbox for 'Microsoft Comm Control 6.0'. You do not have a suitable version of Visual BASIC if this control is not listed.

If it is present, operate the Apply and OK buttons, and the MSCOMM component will then appear with the other components in the toolbox. This makes it possible to add MSCOMM to a form in the usual way. Its 'telephone' icon will appear on the form so that it can be selected, but it will not be visible on the form of the compiled program.

The Properties Inspector gives access to a number of parameters when the MSCOMM component is selected (Fig.1). This is similar to the properties window for the SerialPort (see Fig.3 in the previous *Interface* – June '08), and as in that case, most of the default settings will usually suffice. However, some will probably require adjustment, and the ComPort setting will almost certainly have to be changed if an add-on USB serial port is used.

The ComPort is the serial port that will be accessed by the component, and it is COM1 by default. An add-on USB serial port is more likely to be COM3 or COM4, and where appropriate this setting must be changed to the correct port number. Note that it is possible to use two or more serial ports,

but a different MSCOMM component will be required for each serial port that is used.

The Settings parameter is an important one, and it is used to set the baud rate, the type of parity checking, the number of data bits, and the number of stop bits. By default, this will be 9600-baud, no parity, eight data bits, and one stop bit (9600,n,8,1).

This word format is usually the best one to use when interfacing user add-ons to a PC, but a higher baud rate might be preferable in some applications. 19200 is the highest standard baud rate, and it gives double the default transfer rate, which works out at about two kilobytes per second. To increase the baud rate to 19200 it is just a matter of deleting 9600 and replacing it with 19200.

Turbo speeds

Windows and modern PCs support some 'turbo' baud rates, and one of these can be used if an even higher rate of transfer is required. Some PCs can apparently use a maximum rate of 230400 baud or even higher, but the highest rate that is likely to work with most PCs is 115200 baud. With this baud rate a maximum transfer rate of about 11 kilobytes per second is obtained.

Note that the figure used for the baud rate parameter must correspond to one of the standard rates supported by Windows. Simply using any baud rate that takes your fancy will produce an error message.

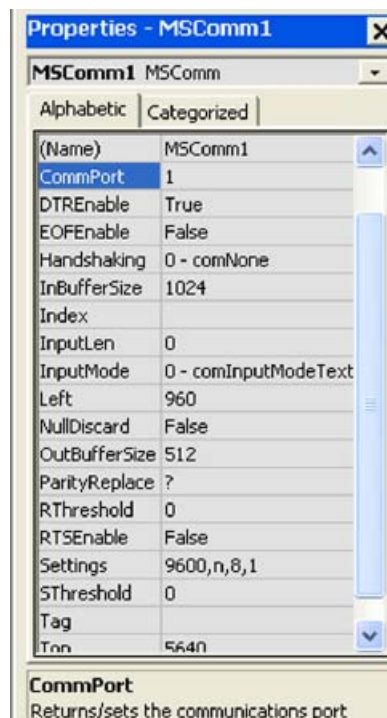


Fig.1. A range of parameters for MSComm can be set via the Properties Inspector. These include the word format and baud rate

There are various handshaking options available, but handshaking is unnecessary with most user add-ons. The speed of the peripheral device and the PC are both likely to be very high compared to the maximum transfer rate of a serial port, even if the port is used at a 'turbo' rate. Serial port handshaking can be problematic, so it is best avoided unless it is really needed for some reason.

When handshaking is not required, make sure that the None option is selected. If any other setting is used there could be problems, with data flow grinding to a halt due to the PC expecting handshake signals that it will never receive.

Hit the buffers

InBuffer and OutBuffer are two more parameters that will usually be important. Programs can read each byte of data as it is received, but it is not essential for things to be handled in this fashion. The byte-by-byte approach may sometimes be the best way of doing things, but bytes are often transmitted in groups of a fixed size. It is then more efficient if the received data is stored in a section of memory called a buffer, and processed when the appropriate number of bytes have been received.

Similarly, a program does not have to wait for one byte to be transmitted before it sends the next one to the serial port. Instead, a block of data can be stored in a buffer. The transmission of this data is then handled by the operating system and not by the application program.

Whether sending or receiving data, it is clearly essential for the buffer to be of adequate size, as it will otherwise overflow and some of the data will be lost. This process is sometimes called 'hitting the buffers', and it more or less guarantees a complete breakdown in communications between the PC and the peripheral device.

The InBuffer and OutBuffer parameters respectively set the sizes of the input (receiving) and output (transmitting) buffers. These values set the buffer sizes in bytes. The default values will usually suffice, but higher values might be needed in applications that send or receive large blocks of data. The size of the buffer must be significantly larger than a single block of data.

Sending data

Sending data using MSComm is very simple, and the only minor complication is that, in common with most serial port components, it is designed primarily for sending and receiving data in the form of strings. In the current context, it will usually be the transfer of numeric data that is required. Fortunately, in basic it is easy to convert numeric data to strings and vice versa.

To test the sending of data using MSComm, add a scrollbar and a command button to the form. The scrollbar properties should be edited so that the maximum and minimum values are 0 and 255 respectively. In other words, it is restricted to 8-bit values that the serial port can handle. The button will be used to close the serial port, and it should therefore be labelled something like 'CLOSE'. The following three routines are used for the form, scrollbar, and command button respectively:

```
Private Sub Form_Load()
MSComm1.PortOpen = True
End Sub

Private Sub HScroll1_Change()
MSComm1.Output = Chr$(HScroll1.
Value)
End Sub

Private Sub Command1_Click()
MSComm1.PortOpen = False
End
End Sub
```

The routine for the form simply opens the serial port using the PortOpen command. There is no need to specify a port number, since the port assigned to MSComm1 is the port that will be opened. The routine for the scrollbar outputs the new value to the serial port each time the slider control is adjusted.

Simply outputting the raw data from the scrollbar will not have the desired effect. With a new value of (say) 145, the ASCII codes for the characters 1, 4, and 5 would be sent to the serial port.

The Chr\$ function is used to convert the new value to its corresponding ASCII character, which is then sent to the serial port. MSComm1 then converts this back to the appropriate 8-bit value and transmits it. There seems to be no reliable alternative to this roundabout way of doing things.

The button can be used to close the serial port, and it is considered good practice to close ports when a program will not be accessing them any more. This enables other programs to access the port. Operating the command button will have no obvious effect unless you then operate the slider of the scrollbar. The program will then try to access a closed port, and an error message will be produced.

Receiving data

Receiving data is not quite as straightforward as transmitting it, but it is reasonably simple using the MSComm component. The transmitter program is easily modified to receive data as well, and it then provides an easy means of checking that data is being sent

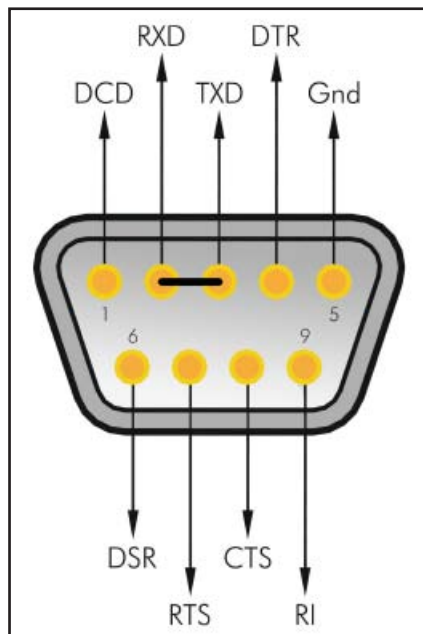


Fig.2. A link between pins 2 and 3 of the serial port enables transmitted data to be read and displayed. Removing the link will 'freeze' the display

and received properly by the serial port.

Linking the TXD and RXD terminals of the serial port (Fig.2) enables the program to read the bytes of data sent using the transmission section. A label must be added to the form so that there is somewhere for the received values to be displayed.

The routine for the form must be modified, and this is the new version:

```
Private Sub Form_Load()
Dim SerData As String
MSComm1.RThreshold = 1
MSComm1.InputLen = 1
MSComm1.InputMode =
comInputModeText
MSComm1.PortOpen = True
End Sub
```

This short routine for the MSComm1 prints received values on the label component:

```
Private Sub MSComm1_OnComm()
If MSComm1.CommEvent = 2 Then
SerData = MSComm1.Input
Label1.Caption = Asc(SerData)
End If
End Sub
```

There are two basic approaches to reading serial data, one of which is called 'polling'. This method involves frequent checking of the serial interface to determine whether any fresh data is available. While polling works well, it

is very inefficient because it results in a great deal of wasted processing time while the serial interface is checked for non-existent data. The alternative method, and the one used here, is the event method. This is much more efficient, and it generates an OnComm() event when a certain number of bytes have been received. The program then responds to this event and processes the data.

The number of bytes needed to trigger an OnComm() event is controlled by the RThreshold parameter, and in this case a value of 1 is used so that the bytes are read one-by-one. The InputLen setting will normally have the same value as RThreshold, and it determines the number of bytes that will be read from the receiver buffer each time the program fetches serial data.

This program uses an If...Then loop to read the received data, and it loops until Comm.Event returns a value of 2, which occurs when the appropriate number of bytes are ready to be processed. Of course, in this case a value of 2 is returned each time a new byte of data is received.

There are actually seven types of Comm event, which are numbered from one to seven, and these are the events that trigger them:

No.	Event
1	Send
2	Receive
3	Change in the CTS line
4	Change in the DSR line
5	Change in the CD line
6	Ring detect
7	End of file

When a byte of data is received and the program breaks out of the loop, the byte is placed into string variable SerData. The stored ASCII character is used as the caption for the label component, but it is first converted into its ASCII code value. This is the opposite of the process used when transmitting data. MSComm does actually have a binary mode, which would seem to be a better choice for interfacing to do-it-yourself add-ons, but using it in practice seems to be problematic.

Results

Fig.3 shows the program running with the link in place across pins 2 and 3 of the serial port. The slider has been set for a high value, which has been transmitted, received, read from the port, and displayed correctly on the label.

In Fig.4 the link wire on the port has been removed, the slider has been set for a low value, but no data has been received. The reading on the label has therefore remained unchanged.

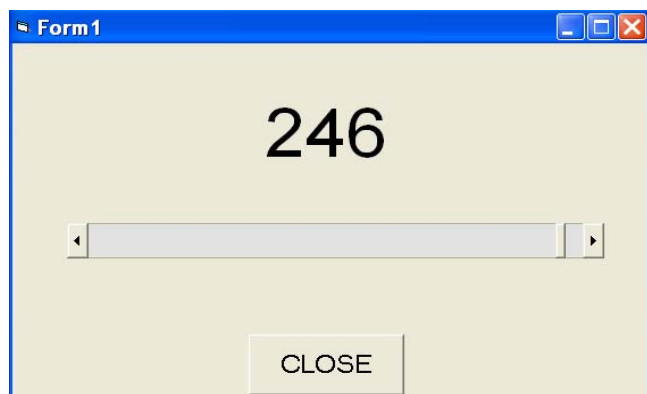


Fig.3. A high value has been set on the slider and the display shows the appropriate value has been read from the serial port



Fig.4. A low value has been set using the slider, but the display has not changed because the link between the port's TXD and RXD terminals has been removed. New values are transmitted but not received.

By John Clarke & Julian Edgar

Using the temperature switch, it's easy to rig warning lights or alarms for excessive engine or gearbox oil temperatures. In fact, anything's that hot in the car (with the exception of the exhaust gas and cylinder head) can be monitored. [Photo: Ford]



Temperature Switch

A cheap general-purpose adjustable design that can work all the way up to 245°C!

THERE ARE MANY automotive performance applications where you want to turn something on or off based on a measured temperature. Radiator cooling fans, over-temperature warning lights or alarms, intercooler or amplifier fans – they all need a cheap and easily adjusted temperature switch.

Temperature switches are available commercially, but this build-it-yourself design has some major advantages over normal thermostats and temperature switches. First, it can be adjusted very finely – you can literally set (to

within a degree) the temperature at which the switch triggers.

Second, the hysteresis (ie, the difference between on and off temperatures) is adjustable. That lets you set the system up so that the device you're switching isn't constantly cycling at the trigger point. You can set a wide hysteresis to switch something on and off at two widely spaced temperatures, or a low hysteresis to keep tighter control – the choice is yours.

Third, the sensor used in this design is good for temperatures up to 245°C. This means you can monitor engine oil or auto transmission oil temperature, or site the sensor near the brakes to trigger cooling sprays. In other words, apart from exhaust gas and cylinder head temperature, you can trigger the switch with anything on the car that's hot or cold.

Finally, you can configure the sensor so that it reacts very quickly to temperature changes.

Construction

The Temperature Switch is simple to build, but you should make one

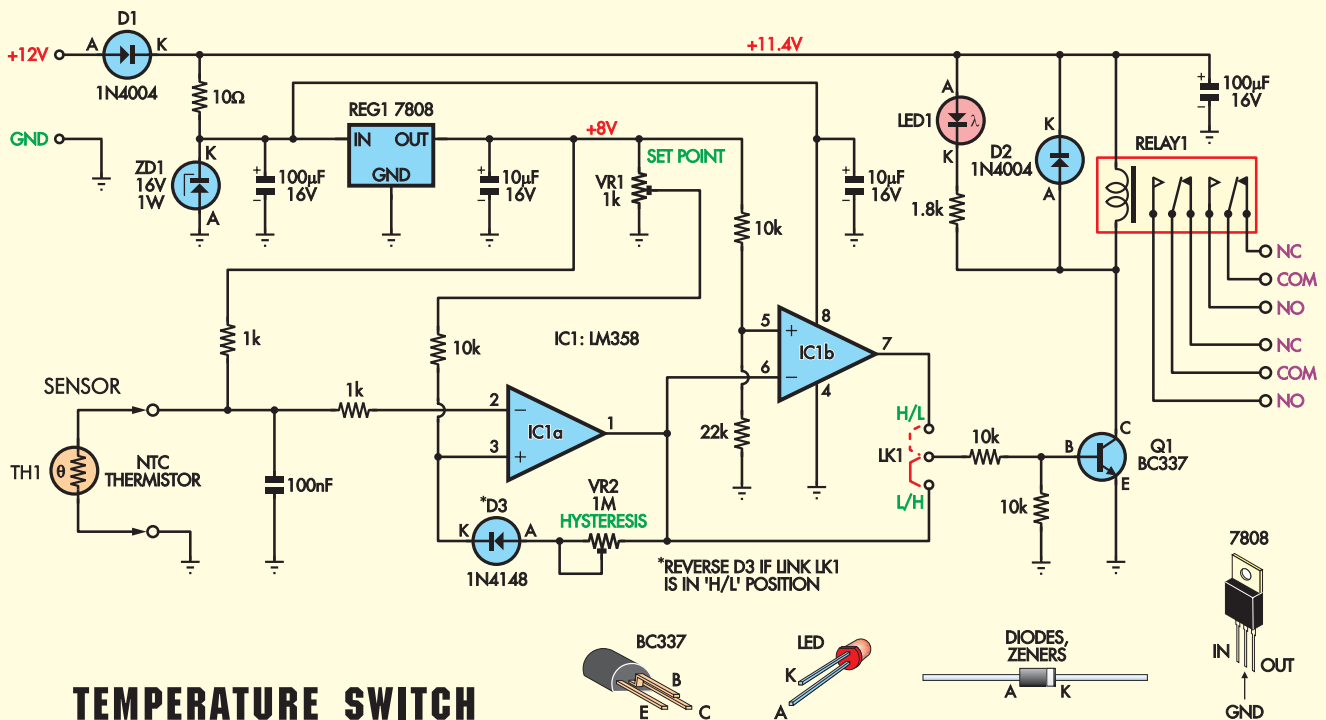
decision before starting construction. Will you be using it to detect a temperature that is rising to the trip point or falling to the trip point? The Temperature Switch can be configured to work either way, but if you know which way you're going, you won't have to make changes later on.

The detection of a rising temperature will be the more common application – for example, turning on a warning light or cooling fans when the temperature gets too high. But if you want something switched on as the temperature falls – for example, activating a warning light when the outside temperature drops below 3°C to warn of the possibility of black ice on the road – then the Temperature Switch needs to be configured for a falling temperature.

So what changes are necessary for the differing configurations? They're simple: for rising temperature detection, link LK1 is placed in its 'L/H' position (ie, to the left when the board is orientated as shown in Fig.2), and diode D3 is positioned so that its band (cathode) is closest to the bottom of the

Main Features

- Adjustable temperature switching from 0°C to 245°C
- Double-pole changeover 5A relay contacts
- Selectable rising or falling temperature switching
- Adjustable hysteresis
- Easy to build



TEMPERATURE SWITCH

Fig.1: temperature is monitored using a thermistor (TH1); while either op amp IC1a or IC1b drives transistor Q1 and the relay, according to a rising or falling temperature – see text. Trimpot VR1 sets the temperature trigger point.

How It Works

The full circuit diagram for the Temperature Switch is shown in Fig.1.

The temperature is monitored using an NTC (negative temperature coefficient) thermistor (TH1); a device which exhibits a variable resistance with temperature. At high temperatures, the resistance of the thermistor is low, while at lower temperatures its resistance is higher.

A 1kΩ resistor from the 8V supply feeds current through the thermistor, which then produces a voltage which is inversely proportional to temperature. This voltage is filtered using a 100nF capacitor and fed via a 1kΩ resistor to the inverting input (pin 2) of op amp IC1a, which is connected as a comparator.

The voltage on IC1a's non-inverting input (pin 3) is set by 'set-point' trimpot VR1 via a 10kΩ resistor. When the thermistor voltage at pin 2 is above the voltage set by VR1 at pin 3, IC1a's output is low. Conversely, when the thermistor voltage is below the voltage on pin 3, IC1a's output is high (around +8V).

Hysteresis has been added to prevent the output of IC1a from oscillating when the inverting input is close to the switching threshold. This hysteresis is provided by trimpot VR2 and diode D3 in series between IC1a pins 1 and 3.

Trimpot VR2 enables the amount of hysteresis (actually positive feedback) to be adjusted. With low hysteresis, the temperature only has to drop by a small amount for IC1a's output to switch low again after it has switched high. If VR2 is set for high hysteresis, the temperature must fall by a much larger amount before IC1a's output switches low again.

Diode D3 sets the direction of the hysteresis action. As shown, it provides hysteresis when pin 1 of IC1a goes high. Alternatively, if mounted in the opposite direction, it provides hysteresis when IC1a's output goes low.

Where the circuit is intended to provide a switched output when the temperature goes above a certain value, the diode is installed as shown on the circuit and parts overlay (Fig.2). If you want the switching to occur when the temperature falls below a certain value, diode D3 is reversed.

Op amp IC1b is an inverter, which provides a signal opposite in polarity to IC1a's output. When IC1a's output goes high, IC1b's output goes low and vice versa.

Link LK1 provides the option for driving the relay with a rising temperature (L/H) or a falling temperature (H/L). It selects the output of IC1a or IC1b to drive transistor Q1 which, in turn, drives the relay. Diode D2 is there to quench the reverse voltage (back-EMF) that is generated by the collapsing magnetic field of the relay coil each time it is switched off.

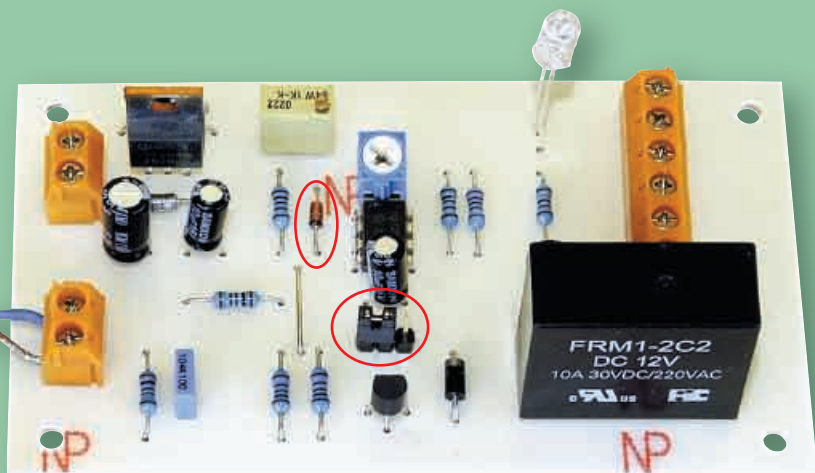
Power is obtained from the car's +12V ignition supply via diode D1, which gives reverse polarity protection. The 10Ω resistor, 100μF capacitor and Zener diode ZD1 provide transient protection at the input of regulator REG1. The circuit is powered via the 7808 regulator with the exception of the relay, Q1 and LED1, which are driven from the 11.4V supply following diode D1.

Resistor Colour Codes

Value	4-Band Code (1%)	5-Band Code (1%)
22kΩ	red red orange brown	red red black red brown
10kΩ	brown black orange brown	brown black black red brown
1.8kΩ	brown grey red brown	brown grey black brown brown
1kΩ	brown black red brown	brown black black brown brown
10Ω	brown black black brown	brown black black gold brown

Constructional Project

The device turns other devices on or off based on the sensed temperature. Its sensor can work over the range of 0°C to 245°C, making it useful for monitoring engine oil, engine coolant and transmission oil temperatures, as well as intercooler and inlet air temperatures. Note that link LK1 (to the left of the relay) must be moved to the H/L position and diode D3 (circled) reversed in orientation if the switch is to trigger on a falling (rather than rising) temperature.



Use the switch to . . .

- Operate electric radiator fans
- Trigger over-temperature warning light/alarm
- Operate amplifier cooling fans
- Operate an intercooler water spray or fan
- Operate a brake cooling water spray
- Reduce turbo boost when intake air temperature is high

board. Conversely, to detect a falling temperature, link LK1 is moved to its alternative 'H/L' position and diode D3's orientation is reversed. Easy, huh?

When assembling the PC board, be sure to insert the polarised components the correct way around. These parts include the diodes, IC, LED,

transistor, voltage regulator and electrolytic capacitors. During construction, follow Fig.2 closely to avoid making mistakes.

Thermistor

The thermistor is of the 'bare' design – ie, it's not potted in epoxy or mounted inside a brass fitting. If you want temperature detection to occur very quickly (ie, if you want the

thermistor to react quickly, even to small temperature variations), the thermistor should be left exposed. However, if the reaction speed isn't so important, but durability is, you can pot the thermistor in high-temperature epoxy and mount it in the end of a threaded brass fitting.

Either way, the thermistor will need to be connected to a length of shielded single-core cable, with the shield (the braid) connecting to the 0V terminal on the PC board. The thermistor isn't polarised – it can be connected either way around.

Insulate the leads of the thermistor using heatshrink tubing so that they cannot short out to each other or to ground (0V). In many cases, the whole thermistor itself can then be covered in heatshrink without slowing its reaction time too much.

Testing

Once the assembly is complete, it's a good idea to bench-test the module to make sure it works correctly. To do this, you'll need to connect the thermistor to the input terminals (remember, braided side of the shielded cable to 0V) and supply power and earth.

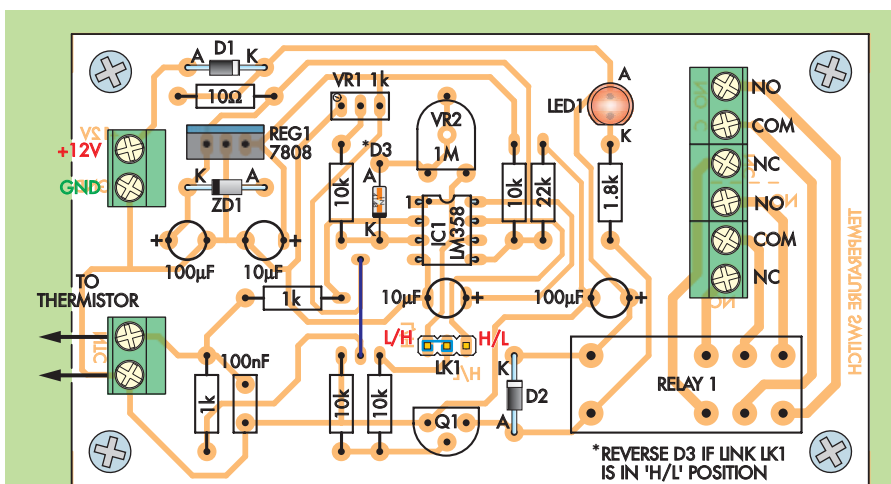


Fig.2: this layout diagram shows where each of the components are placed on the PC board. Don't forget to reverse diode D3 if link LK1 is in the 'H/L' position.

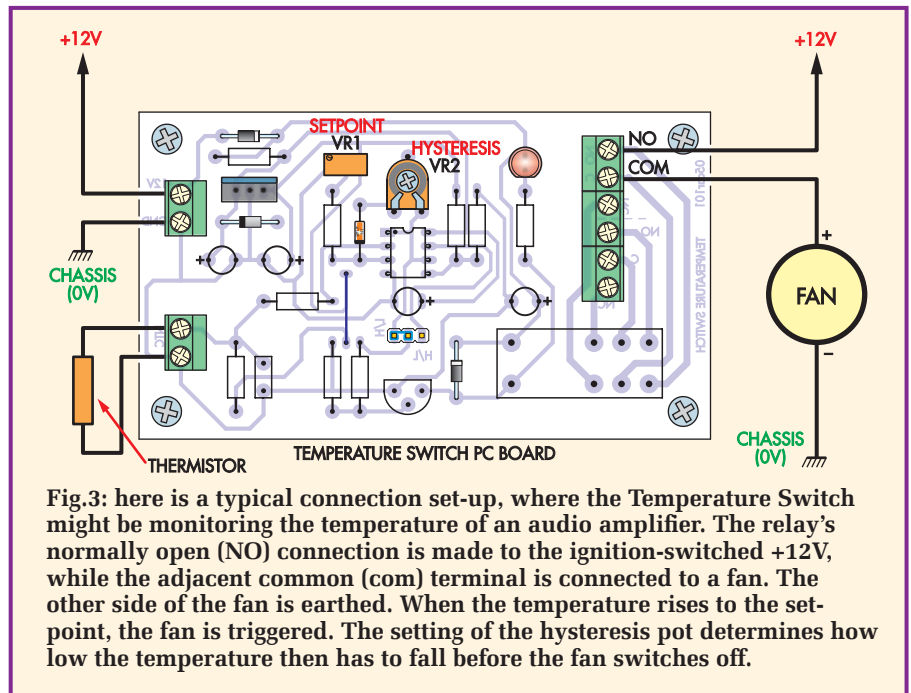
The thermistor's leads should be insulated and then covered in heat-shrink tubing so that short circuits can't occur. If durability in extreme conditions is required (and the sensor doesn't need to react quickly), it can be potted in high-temperature epoxy and mounted in the end of a threaded brass fitting.



First, turn 'hysteresis' trimpot VR2 (just above IC1) fully anti-clockwise. Then turn 'set-point' pot VR1 anti-clockwise until the relay clicks and LED1 comes on. Because VR1 is a multiturn pot, you may need to rotate it a number of times before the LED lights.

Once the switch has tripped, you can then turn VR1 (set-point) back clockwise just enough to turn off the LED and disengage the relay. Now, when you heat the thermistor, the LED should immediately come on and the relay click over; cooling the thermistor should cause the LED and relay to turn off again fairly quickly.

Finally, turn VR2 (hysteresis) clockwise a little, and you should find that the switch takes longer to turn back off when it is being cooled, down after being tripped.



Fitting

Fitting the Temperature Switch to a car is easy. You need only provide an ignition-switched power supply and earth (0V), and then install the thermistor where you want to sense the temperature.

For example, if you are controlling a radiator cooling fan, then you could place an electrically insulated temperature sensor on the top tank of the radiator. Or, if you want the Temperature

Switch to illuminate a warning light when engine or transmission oil gets excessively hot, you could attach the sensor to the appropriate sump.

If you want just the warning light function, you can remotely mount a high-intensity LED within your line of sight – just extend the wires that connect the LED to the PC board, making sure that you keep the LED polarity correct.

If you want to turn a device on and off with the temperature switch, you

Table 1: Setting the trip-point temperature

°C	R _t	V _t	°C	R _t	V _t	°C	R _t	V _t
0	33,944.034	7.771	85	1068.105	4.132	170	126.739	0.900
5	26,120.042	7.705	90	916.558	3.826	175	114.656	0.823
10	20,286.407	7.624	95	789.791	3.530	180	103.954	0.753
15	15,894.535	7.526	100	683.278	3.247	185	94.454	0.690
20	12,557.604	7.410	105	593.399	2.979	190	85.999	0.634
25	10,000.00	7.273	110	517.244	2.727	195	78.458	0.582
30	8023.382	7.113	115	452.462	2.492	200	71.718	0.535
35	6483.660	6.931	120	397.143	2.274	205	65.679	0.493
40	5275.206	6.725	125	349.731	2.073	210	60.259	0.455
45	4319.920	6.496	130	308.953	1.888	215	55.384	0.420
50	3559.575	6.245	135	273.760	1.719	220	50.991	0.388
55	2950.420	5.975	140	243.287	1.565	225	47.023	0.359
60	2459.334	5.687	145	216.818	1.425	230	43.435	0.333
65	2061.059	5.387	150	193.755	1.298	235	40.183	0.309
70	1736.202	5.076	155	173.601	1.183	240	37.231	0.287
75	1469.774	4.761	160	155.938	1.079	245	34.547	0.267
80	1250.116	4.445	165	140.416	0.985			

You can use this table to set the trip point for the temperature switch, where the temperature is shown in the left-hand column (°C) and the voltage required (V_t) to be on the middle pin (moving contact) of the set-point pot (VR1) is shown on the right-hand side. For example, if you want the switch to trip at 145°C, the pot will need to be turned until the measured voltage is 1.425V.



The temperature switch can be used to operate electric radiator fans and you can adjust the difference between the switch-on and switch-off temperatures. With high loads like these fans, you should run an extra heavy-duty automotive relay. [Photo: Bosch]

can use the relay's normally open (NO) and COM (pole) contacts. Fig.3 shows these connections.

The relay's contacts are rated to 5A – for currents higher than this, use the on-board relay to switch another heavy duty automotive type relay.

Note that because a double-pole, double-throw (DPDT) relay has been used, another completely independent circuit can also be switched simultaneously. This other circuit can even turn off the second device as the first is switched on.

Set up

There are two ways of setting the action of the Temperature Switch. First, if you have another means of monitoring the temperature (eg, via an engine-coolant temperature gauge or a temporary temperature probe and display), wait until the measured temperature reaches the desired trigger level, then turn set-point pot VR1 until the Temperature Switch just turns on.

The turn-off value will be set by the hysteresis pot (VR2). If you want the turn-off value to be close to the turn-on temperature, set VR2 fully anti-clockwise. If you want the turn-off temperature to be much lower, adjust VR2 further clockwise.

The other way of setting the trip point is to make some measurements on the bench. Table 1 shows typical NTC thermistor resistance values for a range of

temperatures. The thermistor is $10\text{k}\Omega$ at 25°C and falls to 34.5Ω at 245°C .

Table 1 also shows the expected voltage across the thermistor at each temperature value, assuming the regulator output is at 8V. If the regulator voltage is slightly different to this, then the value will need to be scaled accordingly.

For example, if the regulator output is 7.8V, then the output voltage will be the value shown multiplied by 7.8V, all divided by 8V. You can measure the regulator's output voltage by using a multimeter to probe the righthand terminal of the regulator with the PC board orientated as in the component layout diagram (Fig.2) and photos.

Connect the other probe of the multimeter to ground (0V). Make sure that you don't slip with the multimeter probe and short-circuit the regulator!

When VR1 is adjusted so that a particular voltage shown in Table 1 can be measured on its wiper (moving) terminal, the switch will trip at the corresponding temperature. For example, if you want the relay to close at 120°C , set VR1 so that its wiper voltage is 2.274V. The accuracy will be within about 2%.

Remember, if you wish the relay to close when the temperature goes above a particular value, install link LK1 in position 'L/H' and install diode D3 as shown on the overlay diagram Fig.2. For the relay to close when the temperature goes below a certain value,

Parts List

- 1 PC board, code 678, available from the *EPE PCB Service*, size 105mm x 60mm
- 1 NTC thermistor, SOD27 leaded package, -40°C to 300°C (BC components 2322 633 83103)
- 1 plastic case, size 130 x 68 x 42mm approx. (optional)
- 5 PC-mount 2-way screw terminals with 5mm pin spacing
- 1 12V PC mount DPDT 5A relay (RELAY1)
- 1 3-way pinheader, with 2.54mm spacing (LK1)
- 1 jumper shunt with 2.54mm spacing, for LK1
- 1 3m length of single-core shielded cable
- 1 50mm length of 4mm diameter heatshrink tubing
- 1 $1\text{k}\Omega$ multiturn top adjust trimpot (VR1)
- 1 $1\text{M}\Omega$ horizontal trimpot (VR2)

Semiconductors

- 1 LM358 dual op amp (IC1)
- 1 7808 +8V voltage regulator (REG1)
- 1 BC337 NPN transistor (Q1)
- 1 5mm red LED (LED1)
- 1 16V 1W Zener diode (ZD1)
- 2 1N4004 1A diodes (D1,D2)
- 1 1N4148 signal diode (D3)

Capacitors

- 2 $100\mu\text{F}$ 16V PC electrolytic
- 2 $10\mu\text{F}$ 16V PC electrolytic
- 1 100nF MKT polyester

Resistors (0.25W, 1%)

- 1 $22\text{k}\Omega$
- 2 $1\text{k}\Omega$
- 4 $10\text{k}\Omega$
- 1 10Ω
- 1 $1.8\text{k}\Omega$

install link LK1 in position 'H/L' and install D3 the other way around.

In most applications, once the Temperature Switch is set, it won't need to be altered. The PC board fits into a 130 x 68 x 42mm plastic box, so when the system is working correctly, it can be inserted into the box and tucked away out of sight.

EPE

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Mains Monitor

Design by
John Becker



Keep track of electricity use in your home

RECENTLY *EPE* has been highlighting the need for electrical energy conservation in projects and articles. This design continues that theme, and enables users to keep track of the AC mains power outlet use around their home or other premises, allocating ID code numbers for individual sources.

The design monitors the amount of electrical power used, up to 15A, transmitting data via a radio link back to a central receiving unit connected to a PC via an RS232 serial (COM) port. The PC displays and stores the data for future recall and simple cost analysis. The PC software is believed to run with Windows platforms up to XP. Its suitability for Vista is unknown.

The Mains Monitor may be used with AC mains of 230V or 110V, as selected via the PC, and is suited for 50Hz or 60Hz mains frequency. Fig.1 shows an example of channel waveforms on the main screen. An example of the recall and analysis screen is shown later.

The monitoring unit operates from the AC mains supply, therefore, it should only be built by someone who

is experienced with mains circuits, or is suitably supervised by someone who

is. AC mains can be lethal if wrongly connected, or simply misunderstood.

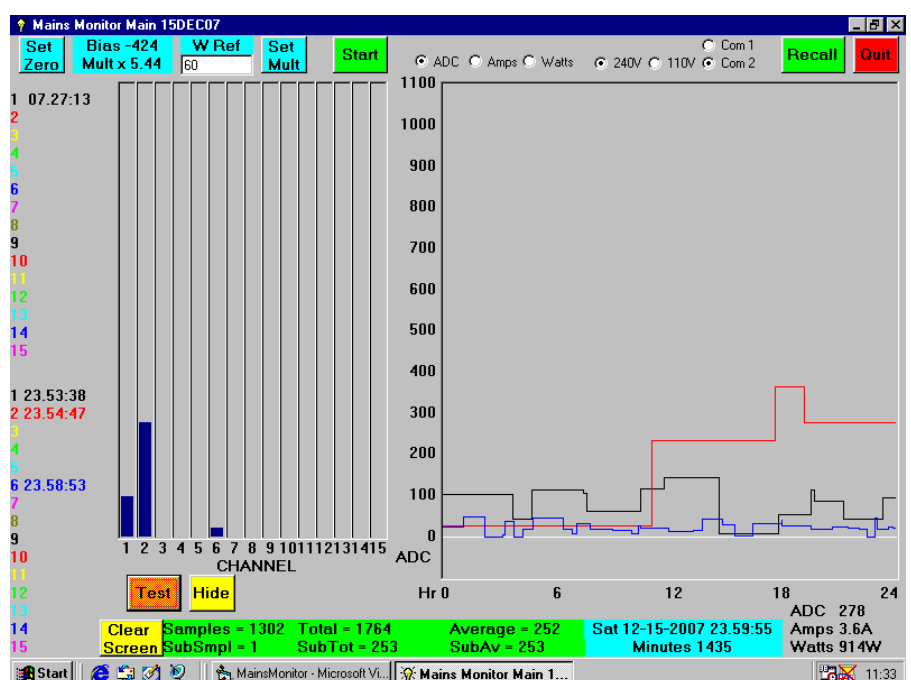
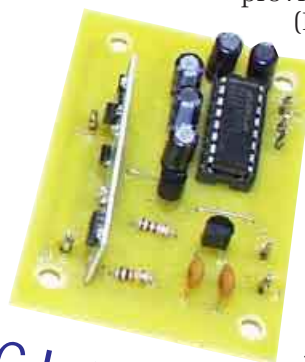
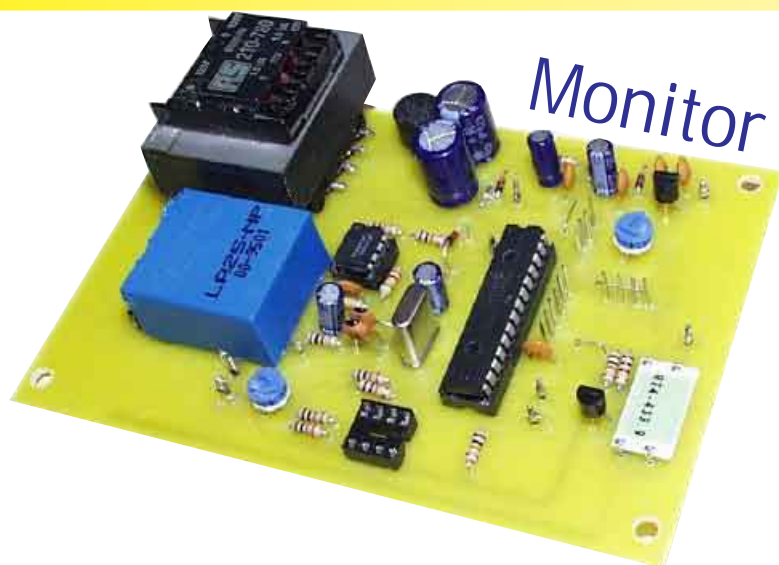


Fig.1: Example of the PC main screen in mains monitoring mode

Constructional Project



The resulting signal is half-wave rectified by D4 and smoothed by C14 in conjunction with R16. The final output is fed to an analogue-to-digital conversion (ADC) facility, provided via a PIC microcontroller (IC1). Preset VR2, when coupled into the circuit, can be used to test the ADC conversion when the current transducer is not connected.

No physical amplitude or biasing controls are provided on the printed circuit board (PCB). These controls are provided in the PC software.

Monitoring circuit

The diagram for the monitoring circuit (one channel) is shown in Fig.2. As in other similar designs, such as *PIC Electric Mk2* (Feb/Mar '05), the author has used a Hall effect transducer (X3) to sense the current drawn from a given mains outlet. This outputs an AC voltage proportional in amplitude to the current being drawn.

The signal is DC coupled to 0V via resistor R11, and AC coupled by capacitor C12 to the op amp amplifying stage around IC4. The gain given by this stage is set at a little over $\times 2$ by the values of resistors R12 and R13. Mid-way bias is provided by the potential divider formed by R14 and R15, with C13 providing stability.

Power supply

Also shown in Fig.2 is the power supply circuit for a single mains monitor module. A PCB-mounted mains transformer (T1) produces twin outputs at 12V AC. These are full-wave rectified by REC1, which results in approximately $\pm 20V$ DC (unloaded) on smoothing capacitors C4 and C9.

Zener diodes D2 and D3, buffered by resistors R9 and R10, regulate the

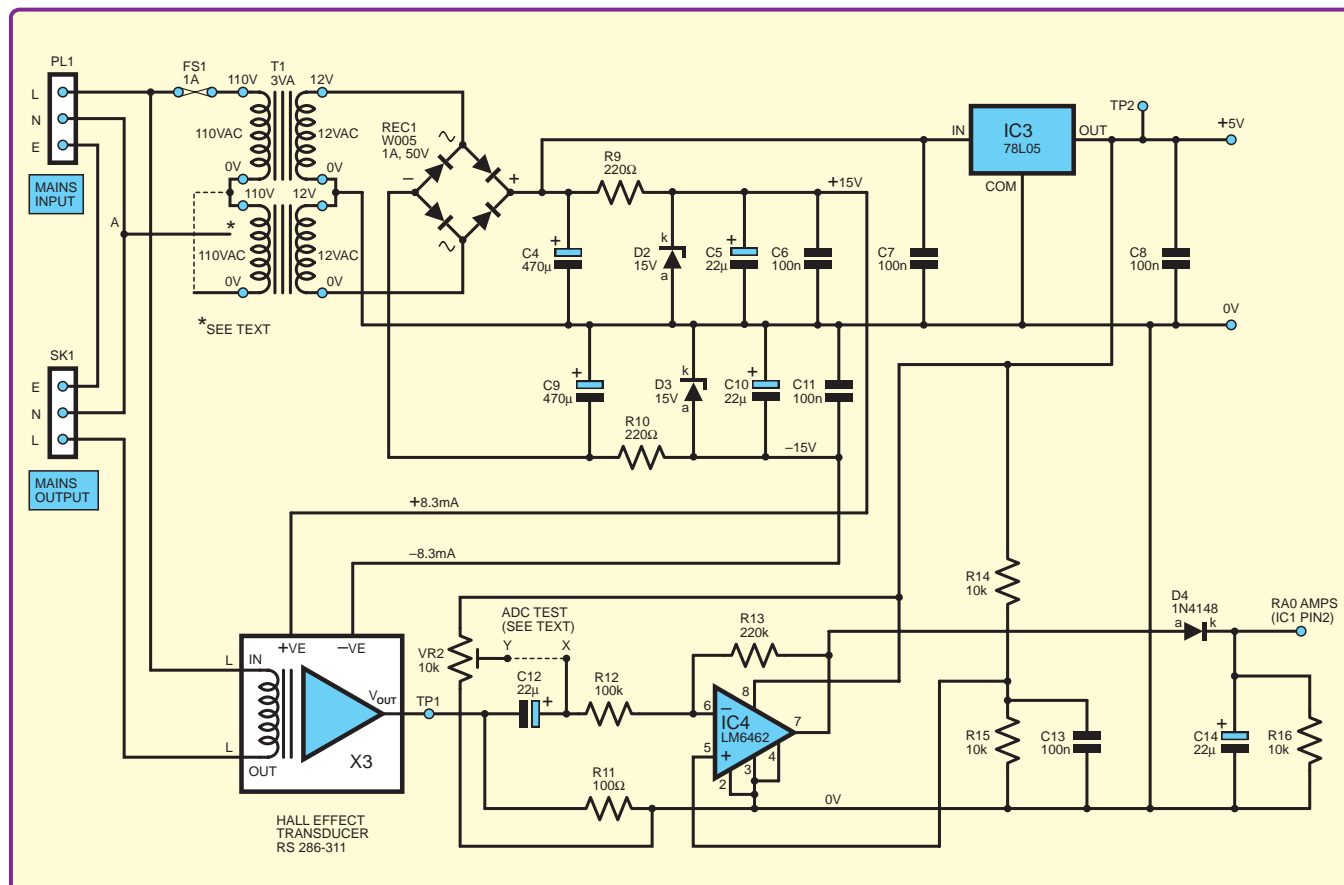


Fig.2: Mains monitoring circuit diagram. This also includes the power supply for driving the master control section

$\pm 20\text{V}$ DC supplies down to $\pm 15\text{V}$, in conjunction with smoothing capacitors C5, C6, C10 and C11. These supplies provide power for the Hall effect current transducer (X3).

The +20V DC supply is fed to regulator IC3, which produces an output of +5V DC, as required by the PIC, transmitter and optional LCD display module.

PIC controller

The circuit for the controlling PIC unit is shown in Fig.3. The PIC16F876A is labelled as IC1. It runs at 3.2768MHz, as set by crystal X1 in conjunction with capacitors C2 and C3.

The PIC's RA0 port pin (2) converts the incoming voltage signal from the power monitoring circuit to an equivalent decimal value. Once a minute, the value is added to a counter and another counter is incremented to keep track of the number of samples taken since monitoring began from switch on, or reset via switch S2.

At the same time, the totals are transmitted to the PC via buffer transistor TR1 and the 433MHz radio

transmitter (TX) module IC2. The TX module can be used without a transmitting licence as it conforms to the legal requirements in terms of frequency and transmitting power. It is available as a ready-made unit from a variety of sources. The one in the model came from RS Components, and was manufactured by RF Solutions. The aerial for the TX module is part of the PCB and is of a fixed legal length.

Identity code

Multipole switch S1 is connected to the PIC and is used to set the identity code of the monitoring board, between 1 and 15. The switch outputs are biased normally high, and turning on a switch sets a given output low.

At power-on or reset, the PIC reads the status of the switch outputs and sets the unit ID accordingly. This ID is always transmitted with the total monitoring counts, so that the receiving PC knows from which source the values have been sent.

Switch S2 is a reset switch, which allows the PIC software to

be restarted without power being switched off and on again. Switch S3 allows the transmission of the PIC software's timing value when testing the module.

Provision has been made for an optional alphanumeric LCD (X2) to be used with the monitoring module so that current ID values and monitoring quantities can be viewed at source. Preset VR1 allows the LCD contrast to be set.

Connector TB1 is also optional, it allows the PIC to be reprogrammed *in situ* if you wish. It was used when developing the prototype unit.

COM interface

Communication with the PC is via the RS232 interface circuit in Fig.4. It uses the standard MAX232 serial interface chip (IC6). The unit cannot be used directly with a USB port, although there are serial-to-USB converters widely available; browse **www.google.com**.

IC6 is fed by signals received by the 433MHz RF receiver (RX) module IC5, and buffered by transistor TR2. The RX module is a matching

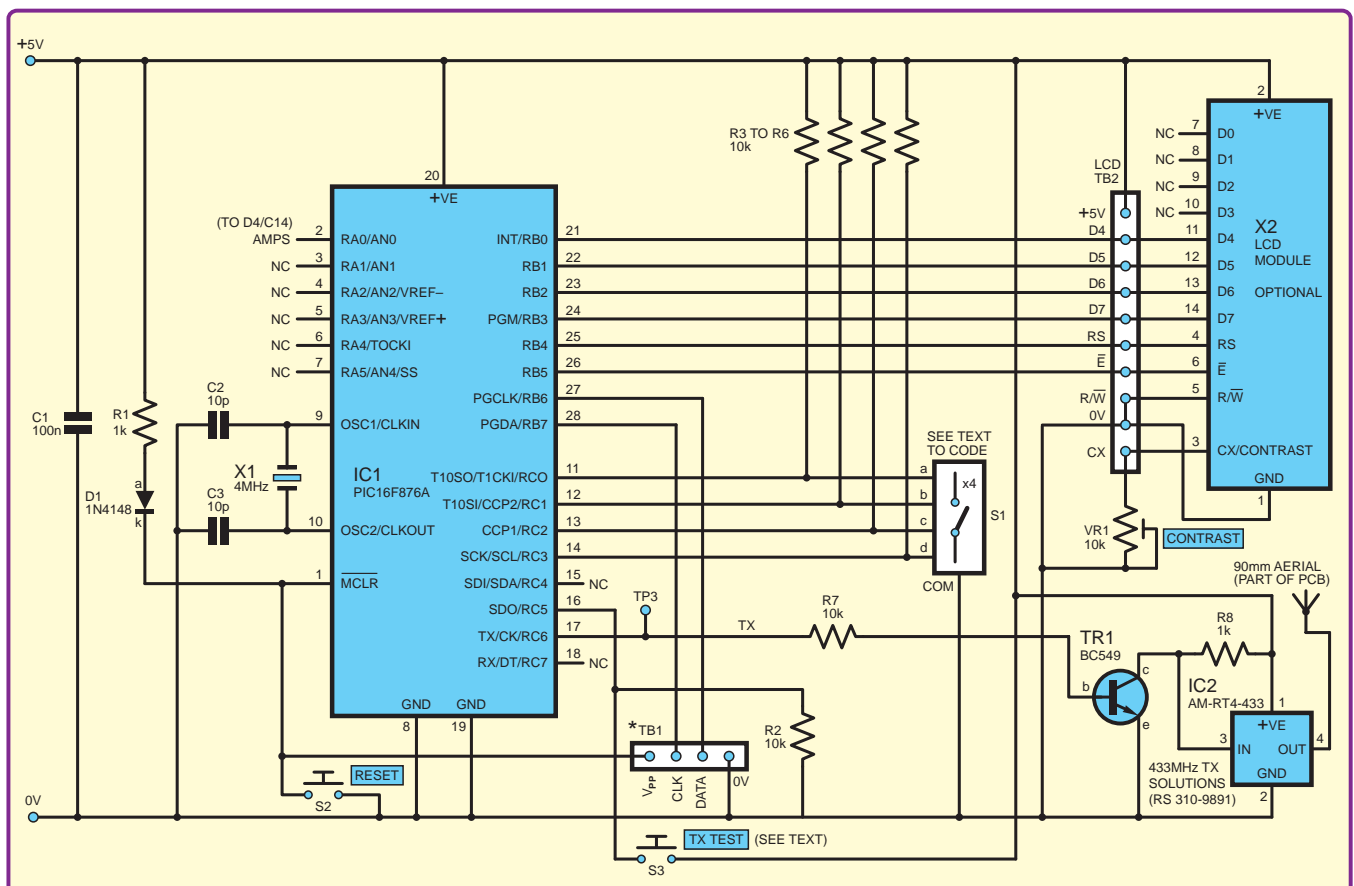


Fig.3: Master control circuit diagram.

Constructional Project

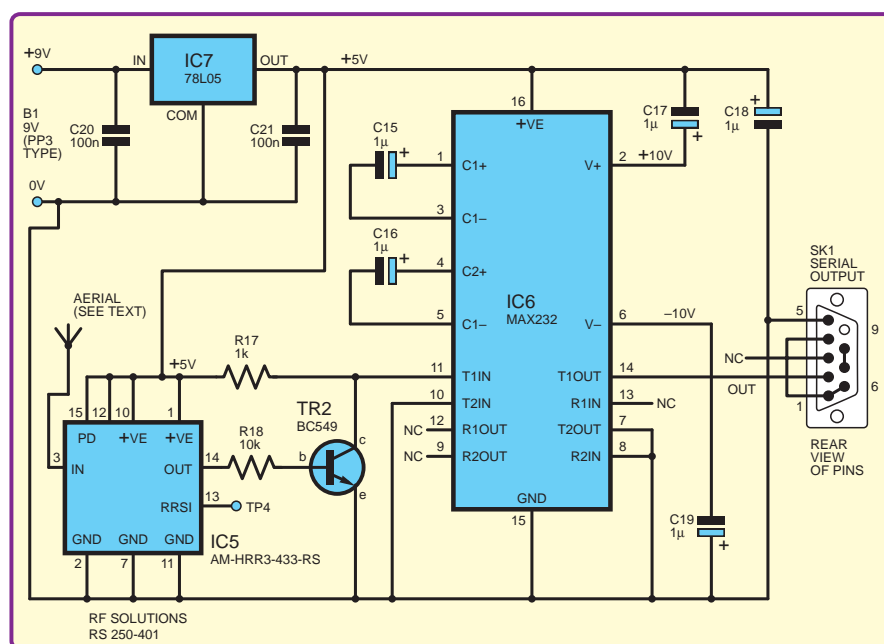


Fig.4: RS232 PC interface circuit

unit to the TX module from RF Solutions and is equally widely available. The author's came from RS Components.

The interface receiver module is connected to the PC via a standard serial cable and is separate from the TX module(s). It has to be powered

by a 9V DC source, such as a PP3 type battery. Regulator IC7 reduces the supply voltage to +5V, as required by the RX and RS232 devices.

A separate aerial (external connecting wire) must be used with this module and may be of any suitable length as found by experiment. The aerial used with the prototype was about 90mm long, but greater lengths may be required in other situations.

Assembly

There are two PCBs for this design; one each for the Monitoring Module and PC Interface. These boards are available from the *EPE PCB Service*, codes 679 (Monitor) and 680 (Interface).

The S1 switch selection of monitoring module ID values can be made via a panel-mounted binary selector switch, so that the ID can be changed as the monitoring module is placed in different locations. A PCB-mounted DIL (dual-in-line) switch could be used instead, although less conveniently.

Parts List – Mains Monitor Module

- 1 PC board, Code 679 (Monitor), available from the *EPE PCB Service*
- 1 Plastic case, size and type to individual choice
- 1 3VA PC-mounting mains transformer: twin 110V AC primaries; 12V AC secondaries (T1) (RS 210 780)
- 1 mains plug, socket and cables to suit
- 1 6-way 15A mains screw-terminal connector strip
- 1 1A fuse and holder, chassis mounting (FS1)
- 4 single-pole sub-min. toggle switches, or alternatives – see text (S1)
- 1 single-pole pushbutton switch, push-to-make (S2)
- 1 SPST toggle switch (S3)
- 1 3.2768MHz crystal (X1)
- 1 Hall-Effect current transducer (RS 286-311) (X3)

- 1 2-line 16 characters (per line) alphanumeric LCD (optional – see text) (X2)
- 1 4-way pinheader, 1mm pitch (TB1)
- 1 10-way pinheader and connector, 1mm pitch (TB2)
- 1 8-pin DIL socket
- 1 28-pin DIL socket
- 4 Nylon self-adhesive PCB mounting pillars

Semiconductors

- 2 1N4148 signal diodes (D1, D4)
- 2 15V 400mA Zener diodes (D2, D3)
- 1 W005-type 50V 1A bridge rectifier (REC1)
- 1 BC549 *NPN* transistor (TR1)
- 1 *PIC16F877A microcontroller, preprogrammed – see text (IC1)
- 1 LM6462 dual rail-to-rail op amp (IC4)
- 1 78L05 +5V 100mA voltage regulator (IC3)
- 1 AM-RT4-433 transmitter module (RF Solutions – see text) (IC2)

Capacitors

- 2 10pF ceramic, 0.2in pitch (C2, C3)
- 6 100nF ceramic, 2.0in pitch (C1, C6 to C8, C11, C13)
- 4 22 μ F 25V radial elect. (C5, C10, C12, C14)
- 2 470 μ F 25V radial elect. (C4, C9)

Resistors (0.25W, 1% carbon film)

- 1 100 Ω (R11)
- 2 220 Ω (R9, R10)
- 2 1k Ω (R1, R8)
- 9 10k Ω (R2 to R7, R14 to R16)
- 1 100k Ω (R12)
- 1 220k Ω (R14)
- 2 10k Ω min. round carbon preset potentiometers (VR1, VR2)

*Preprogrammed chips are available from Magenta Electronics (www.magenta2000.co.uk)

Mains Monitoring Board

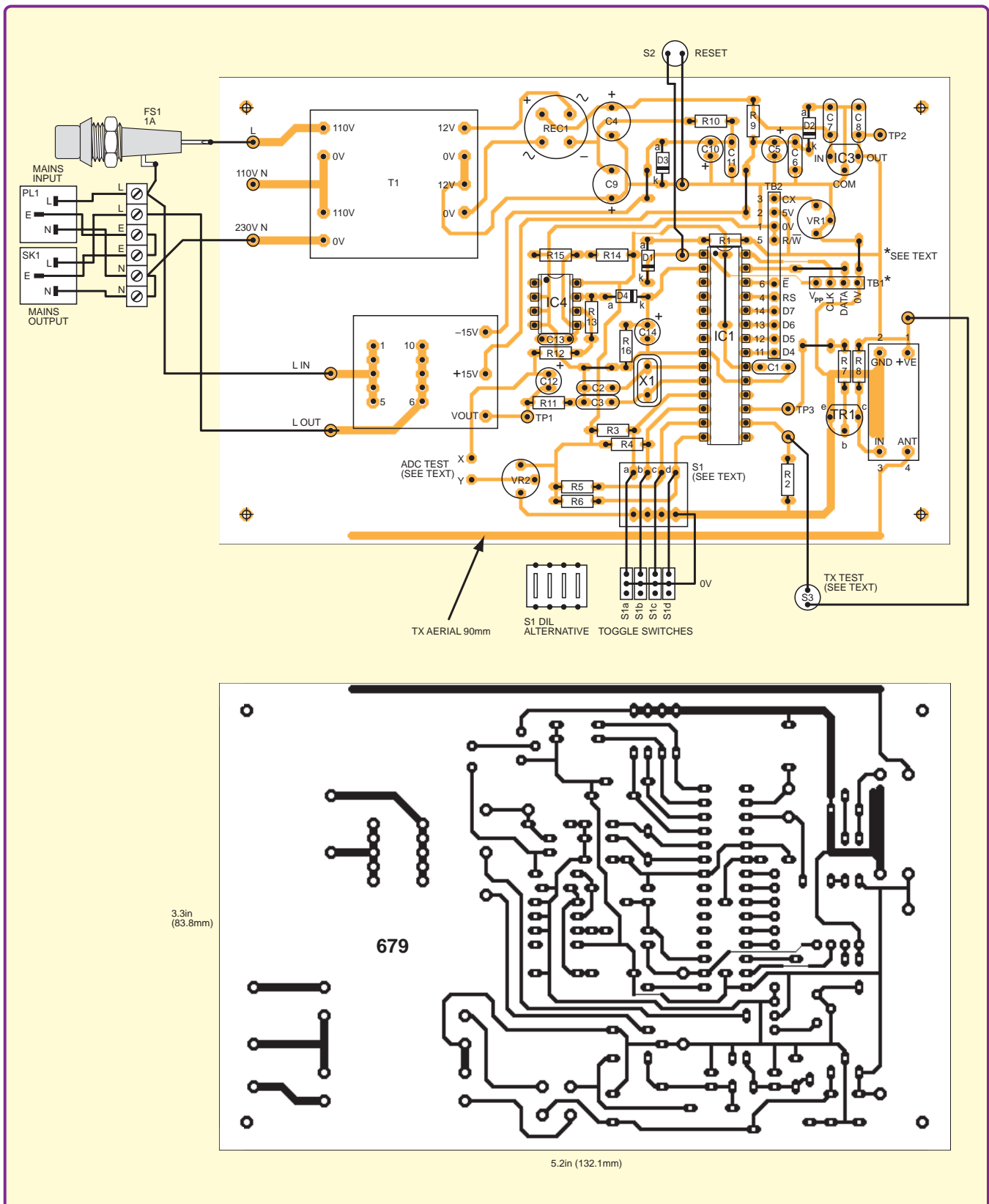


Fig.5: Assembly details for the mains monitoring PCB. The identity code (ID) switches S1a-d can be individual sub-miniature toggle types, a 4-way DIL or binary switch

PC Interface Board

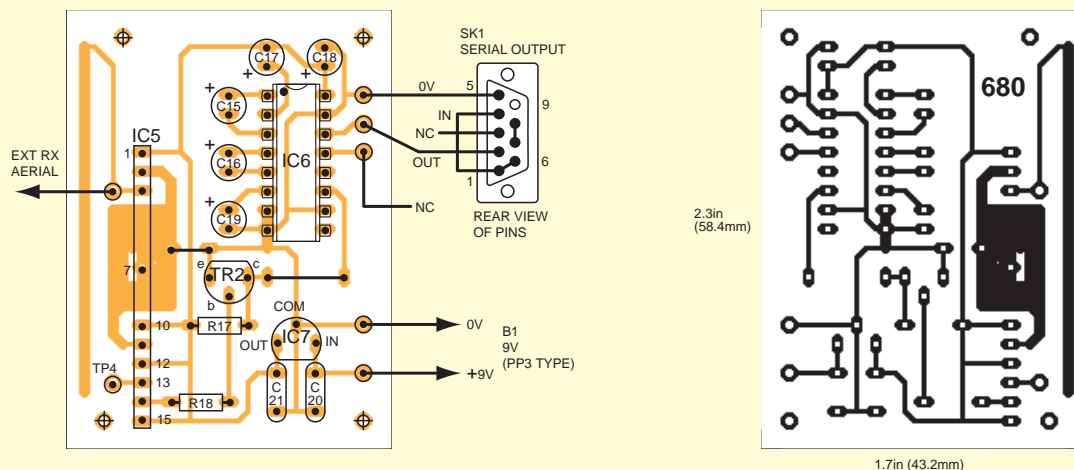


Fig.6: Assembly details for the PC interface circuit

Assembly and component layout details for the monitoring module are shown in Fig.5, those for the PC interface are in Fig.6.

Assemble in the usual order of ascending component size, starting with the on-board link wires. Note that some go under IC positions. Observe the correct polarity for the semiconductors and electrolytic capacitors, as shown on the PCB layouts.

Do not insert the DIL ICs, RF modules, LCD or transducer X3 until the correctness of the +5V and ± 15 V power supply lines has been proved. Also check the supply line voltages after the respective named parts have been connected. A variation of a few tens of millivolts in the supply line levels is acceptable.

It is best if the mains transformer is initially omitted and the circuit checked using a ± 15 V DC power

supply. Only when everything has been checked should the transformer be inserted and connected to the mains.

The connections required for the AC mains are shown in Fig.5. Connection to the PC from the RS232 interface, via socket SK1, should be via 9-pin serial connectors and cable, which should be of the type normally used to connect serial modems to a PC.

Parts List – PC Interface Module

- 1 PC board, code 680 (Interface), available from the EPE PCB Service
- 1 Small plastic case, size and type to individual choice
- 1 16-pin DIL socket
- 1 9-pin D-type connector, female (SK1)
- 1 9-way D-type connector lead, with plug and socket

Aerial wire – see text; multi-strand connecting wire; Nylon self-adhesive PCB mounting pillars (4 off); solder pins; solder etc.

Semiconductors

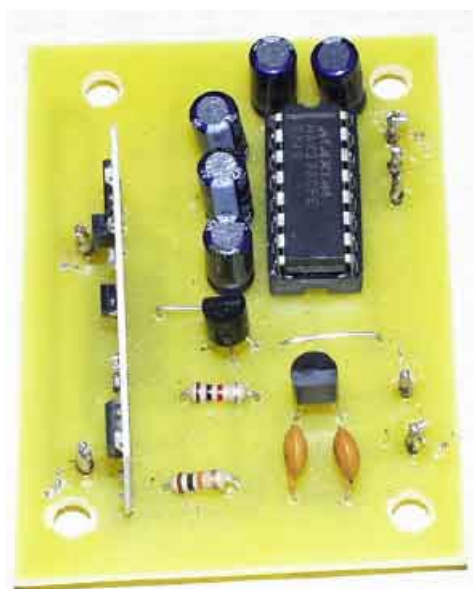
- 1 BC549 NPN transistor (TR2)
- 1 MAX232 RS232 serial interface (IC6)
- 1 78L05 +5V 100mA voltage regulator (IC7)
- 1 AM-HRR3-RS 433MHz receiver module (RF Solutions – see text (IC5))

Capacitors

- 5 1 μ F 16V radial elect. (C15 to C19)
- 2 100n ceramic, 0.2in pitch (C20, C21)

Resistors (0.25W, 1% carbon film)

- 1 1k Ω (R17)
- 1 10k Ω (R18)



Component layout on the PC Interface circuit board

In the prototype, four individual single-pole miniature toggle switches were used for S1 (a to d). A 4-way DIL switch may be used instead, although less conveniently. There are also panel mounting rotary BCD switches available which could be used, although the author has not tried this and cannot recommend any particular type.

Both PC boards should be housed in suitable plastic cases. The Mains Monitoring Board must be in a 'double insulated' case ie no metal parts must pass through the case – use plastic switches and nylon fixings for the PC board. It is not possible to use and earthed metal case as this interferes with the radio transmission. The mains input lead must be securely fixed with a suitable cable clamp.

Software

Software for the PICs and PC is available for free download via the *EPE* website, access via www.epemag.wimborne.co.uk. Preprogrammed PICs are available from **Magenta Electronics**. See their advert in the current issue for contact details.

The PC software was written in Visual Basic 6 (VB6), but is supplied as both a standalone .EXE file and the source code. To run the .EXE you do not need VB6 to be installed. If running the PC source code via VB6, you also need to have installed Joe Farr's *Serial Interface* software, which can be downloaded free from the *EPE* website. Without Joe's program, the Mains Monitor source code will not function when run, and will crash.

PC communication is at 2400 Baud and this rate is built into the software. The COM port used by the PC may be selected as COM1 or COM2. There are 'radio' buttons provided on the main PC screen for selection. The chosen port value is stored for future recall. It may be changed at any time when the program is not actually recording.

On first running the PC software the opening screen will be similar to that shown in Fig.1, but without



Component layout on the prototype mains monitor board. The Hall effect transducer (X3) is just below the mains transformer and the transmitter (TX) module is far-right. The 8-pin DIL socket at the centre bottom edge of the board is for a 4-way DIL switch – see text



Fig.7: Example of the LCD screen shortly after starting

waveforms of course. The COM port selection will be seen at the top right of the screen (as shown in Fig.1), select the COM Port required. The initial default is COM1.

Recording monitored data

In the initial testing stages, switch on S3 so that the PIC's clock counter value is automatically transmitted every second.



Fig.8: Example of the LCD screen during monitoring

On PIC switch-on or reset, the LCD (if connected) will, for the first 60 seconds, show the PIC's time value incrementing and display the unit's identity (Fig.7). The display then changes to show the incrementing time and average ADC value on

Line 1, total accumulated current value and the number of samples on Line 2 (Fig.8).

The PC interface module must be connected to the COM port input and powered. Do not connect anything to the current transducer at this stage.

To run the PC software in Record mode, click the Start button on the main screen. At the top left of the screen should be seen the timing counter value transmitted by the PIC, changing every second. The position where it is shown depends on the ID value also transmitted.

Different display colours are used depending on the ID value of the transmitting module. Black is that used for module ID1. The waveforms plotted on screen are also of the same colour.

There are 15 vertical bargraphs towards the left of the screen. These display the equivalent amplitude level of any unit's last received waveform value.

After every 60 seconds of PIC time, the waveform data is also transmitted and plotted on screen. The entire display width on the PC screen represents 24 hours of data, which is plotted on screen in relation to the present time, as known to the PC. The lower lefthand part of the screen shows the real time at which waveform data for a module is received, allocating different display colours and positions to the time-stamped data.

Checksum

Incoming values, both time and current data, contain a checksum. The PC checks that the checksum value corresponds with its own assessment of the byte data received, and only if the two values correspond does the PC accept that the data is valid.

Position the TX and RX modules so that data is adequately and consistently received. This may entail changing their angles in relation to each other to ensure maximum reception.

Check that the TX module correctly sends receivable data. When it is known that time and waveform data is being received, note the position on the waveform screen where the waveform is being plotted. It will develop as a straight line at this time because the monitoring module is not monitoring mains current being used.

The output of the op amp to the PIC's ADC is biased to be about a half-way value, resulting in an ADC conversion value above zero. Consequently, at this time the displayed waveform will be higher on the screen than it should be.

When the incoming values are known to be consistently arriving, click on the Set Zero button at the top left of the screen. This sets the present data value into a memory register. From then on, this memorised value is deducted from any further incoming waveform values so that they are now always related to the zero position on screen. The 'offset' value is automatically stored to disk for future recall each time the program is run.

Mains test

Once the zero position has been set, plug in a mains powered unit that draws a known current, say a 100W table lamp, and switch it on. On the main PC screen click the voltage setting 'radio' button for 230V or 110V, to suit the known standard AC mains voltage (RMS). This setting is also stored for future recall.

Incoming above-zero current waveforms will now be plotted to screen at an appropriate position above the zero point. Towards the top of the PC screen is a text box (marked W Ref) into which you type the reference current consumption

(eg 100W) of the unit being monitored. Just type the value, *do not* press <Enter> on the keyboard.

With the incoming values now being received consistently, click on the Set Mult button on the screen. The value is stored to disk for future recall and represents the screen position that waveforms in respect of (eg) 100W consumption should take. Other consumption values are plotted at similarly related screen positions, both as waveforms and in the bargraphs. No further setting-up is required.

You will notice on the main screen (Fig.1) that the green labels at the bottom of the screen display numerical values related to incoming data. They were placed there for the author's development use and may be ignored. It may be noted though that the SubSmpl count value will normally be showing as '1' once a module is well into its monitoring. This may sometimes be a higher value – if an incoming value's checksum is unacceptable for some reason, the count value will rise to show the number of samples since the last sample was acceptable. Calculations take this into account.

At the bottom right of the screen are shown the equivalent ADC, amps and watts values for the last acceptable data. The blue label, to the left, displays the current day, date and time as determined by the PC's own internal clock, along with the number of minutes that have passed during the current day. This is only for information.

Of interest to other programmers is the way in which the day name has been calculated. The formula was found on the web (via www.terra.es/personal2/grimmer/) following advice from readers on the *EPE Chat Zone* (via www.epemag.co.uk). Examine the Mains Monitor VB6 source code to see how it was implemented.

Between the bargraphs and display screen are shown the numerical values also associated with the screen display position. The units shown may be changed between ADC, amps and watts by clicking the allocated 'radio' button at the top centre of the screen. The selection is not stored to disk and will revert to ADC next time the program is run.

Storing data

Each incoming waveform value is automatically stored to disk for further analysis. Data is stored consecutively to a file whose name shows the current date, eg **Mainsmon12-15-2007.txt** (in order of month, day of month and year).

Even if the PC program is halted and restarted, data is concatenated to (placed at the present end of) the file. The file name is automatically changed to a new file name following a date change. Even when the PC is run for the very first time, an appropriately named file is created.

To stop recording at any time, click the Stop button (previously marked as the Start button). In point of fact, the recording file is never 'open' except when data is actually being concatenated to it, so the program may be exited safely just by clicking on the usual 'X' button at the screen's top right, or the Quit button.

The screen's Clear Screen button is not normally used, but can be clicked if the recorded waveforms become crowded during long-term monitoring.

Recall screen

Any named file can have its values recalled and displayed via the Recall Screen. Click the same named button at the top right of the main screen to display it – see Fig.9.

There are four methods by which files can be viewed: those relating to the current date, a named date, dates between two given dates, and files since a given start date. Any date that does not have a file associated with it is simply ignored by the software, it does not crash for such reasons. The name of the last file processed is shown in the blue box at the top of the screen.

There are four text boxes associated with the selection. Key in the dates you require. If you wish to store them for future use the next time the program is run then click the Save Dates button. The initial dates are those last used by the author.

To select the display type, click the appropriate radio button. To start the display, click the Start button.

Data values within any existing file called are plotted to screen in the area provided, again with

different colour lines representing the unit ID with which the data is associated (files always have the respective unit ID recorded along with its data).

Data is displayed either as a continuous trace for each unit, or as non-continuous lines relating to any breaks in recording. The screen width represents 24 hours of data, and data from different dates always commences at the left. The values associated with different dates can thus be compared.

You may also display the data for any given unit ID. If you click the Select Units box at the top of the screen, a drop down 'Combo' box appears, giving the various unit ID options. Normally, the first option is shown clicked, so that data for all IDs is shown. To select individual IDs, click off the 'All Units' 'X' box. Then click any chosen other unit ID box so that its 'X' box is shown to be active.

Now, when the Start button is clicked, only data for the selected unit IDs will be displayed. This selection will remain the choice until the selected IDs are changed or the program terminated. The default is always for All Units.

Cost per unit

At the bottom right of the screen are two boxes into which you enter the cost per unit (kilowatt-hour) of electricity used. The current price may be found on your last electricity bill. Enter the value into the upper box and the symbol you want to be shown for the currency involved, eg £ or \$. When the boxes have been given data, click the Save Cost button to store the data to disk. (All values stored to disk can be examined through the **MainsMonitorSettings.txt** file if you wish.)

When the Start button is clicked, the waveform values are related to the cost factor and running totals calculated. When all the wanted waveforms are on screen, the boxes at the left of the screen are updated with the costs represented by the display. The screen is always cleared of previous data when the Start button is clicked.

If you move the mouse cursor across the display screen, the ADC, amps and watts values at the cursor position are displayed at the bottom left of the screen.

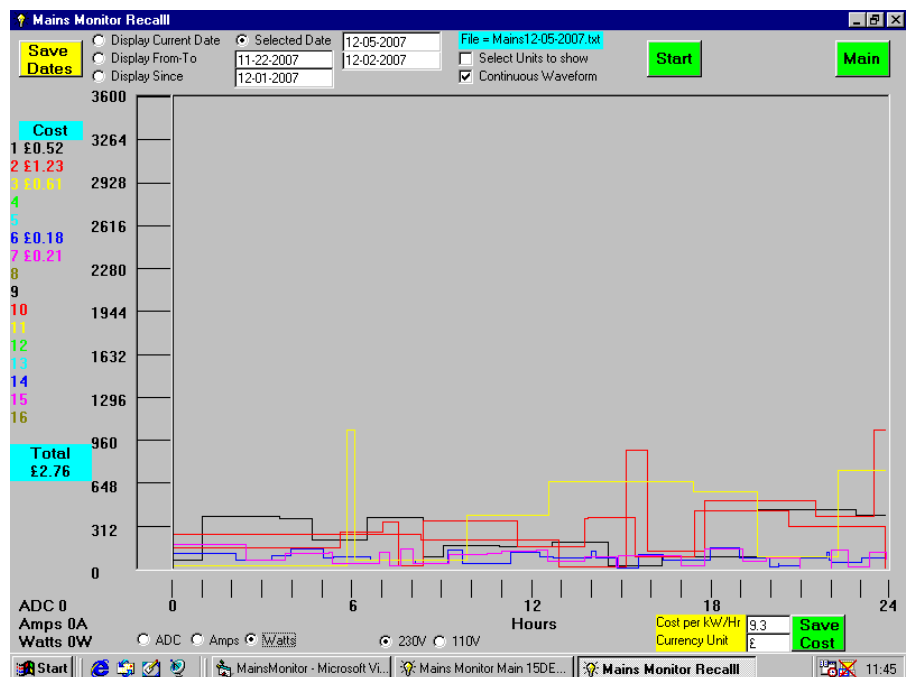


Fig.9: Example of the PC Recall screen displaying a file's waveform

You also have a choice of which notations are used at the left of the screen, and whether the voltage is related to 230V or 110V RMS. Click the respective 'radio' button.

To return to the main recording screen, click the Main button at the top right. Clicking the screen's 'X' button exits the program entirely.

Multiple unit use

It is possible to have several monitoring units all running at the same time and each having different IDs. They jointly send their data back to the PC. This enables longterm monitoring of several power users simultaneously. Additional copies of the TX board should be built to achieve this, up to a total of 15 TX units. Only one PC interface is needed.

The ID selection switches may be replaced by link wires inserted appropriately for each module, in binary fashion.

You do not need an LCD for each module if you connect one via a pin header and connector – just swap between units if you want to check something.

There is a danger of transmission data from one TX module overlapping data transmitted by another, resulting in data not being received correctly. In the early stages of design, experiments were made by

having a transmitter and receiver module on each board.

Handshaking was then used, with the PC transmitting the ID of the module it wanted to send data. The tests were unsuccessful as the transmitters interfered with their nearby receivers. A way round this problem could not be found and the technique was abandoned.

Consequently, when using multiple modules, it must be ensured that none transmit at the same moment as others. The transmission periods are only brief and it is quite easy to stagger the timings so that overlaps do not occur.

If overlap does occur, press the Reset switch on any board to restart the PIC program to allow transmission at a slightly later time than used by other boards in sequence. All transmissions must take place within a period of 60 seconds.

The use of the Test switches (S3) will show whether or not overlap is occurring when examining the PC Main screen and its timing display boxes on the left. It may be useful to have a second person to help in this staggering. It may, however, prove tricky to have more than one S3 switched on at the same time.

We hope the use of this design will help you to economise on electricity use.

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SP8 10 x 3mm Yellow LEDs	SP144 5 Pairs min. crocodile clips (assorted colours)
SP9 25 x 3mm 1 part LED clips	SP146 10 x 2N3704 transistors
SP10 100 x 1N4148 diodes	SP147 5 x Stripboard 9 strips x 25 holes
SP11 30 x 1N4001 diodes	SP151 4 x 8mm Red LEDs
SP12 30 x 1N4002 diodes	SP152 4 x 8mm Green LEDs
SP18 20 x BC182B transistors	SP153 4 x 8mm Yellow LEDs
SP20 20 x BC184B transistors	SP154 15 x BC548B transistors
SP23 20 x BC549B transistors	SP156 3 x Stripboard, 14 strips x 27 holes
SP24 4 x CMOS 4001	SP160 10 x 2N3904 transistors
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SP33 4 x CMOS 4081	SP167 5 x BC107 transistors
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SP104 15 x 16-pin DIL sockets	SP192 3 x CMOS 4066
SP109 15 x BC557B transistors	SP195 3 x 10mm Yellow LEDs
SP112 4 x CMOS 4093	SP197 6 x 20-pin DIL sockets
SP115 3 x 10mm Red LEDs	SP198 5 x 24-pin DIL sockets
SP116 3 x 10mm Green LEDs	SP199 5 x 2-5mm mono jack plugs
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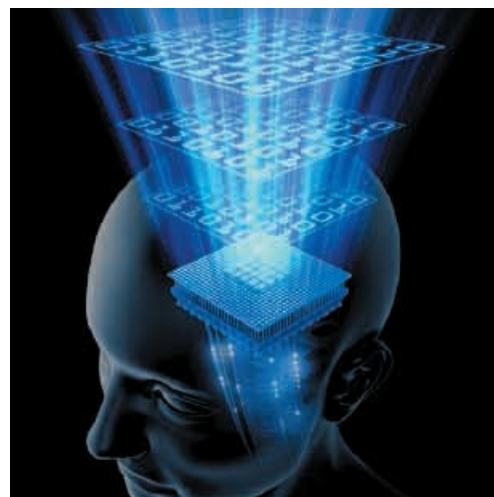
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Teach-In 2008

Part Ten - Examining a program's construction, a game of Dominoes, plus LCD symbol creation

JOHN BECKER



WE have now reached a point where it is worthwhile discussing a practical full-length program and part of its construction. It illustrates a variety of concepts to which you have been introduced earlier, plus further information on alphanumeric LCD use, with particular regard to creating your own display characters.

The program is for the author's Mock Dominoes self-entertainment game (previously unpublished) in which the user plays against a PIC, with moves displayed on an LCD. The circuit diagram and breadboard layouts are shown in Fig.10.1 and Fig.10.2.

The program is too long to be shown here, and only the occasional extracts will be discussed. The full program is in TeachInX01.asm, available in the usual way from our website (via www.epemag.wimborne.co.uk).

Description

Referring to Fig.10.1, the circuit consists of the PIC and LCD on the Teach In 2008 Demo PCB, and four switches on the breadboard. Some of the switches have a multiple function, as will become apparent.

When the program is run, the usual initialisation procedures take place. There then ensues a routine in which the two numeric sides of dominoes are created. At the moment, they are represented by numbers 0 to 6 in the standard numeric form. We shall illustrate later how they can be replaced by LCD symbols representing the dots ('pips') on a normal domino.

The game is limited to seven domino tiles for each player, you and the PIC. Originally, the author used QBasic to simulate the requirements for creating the 28 possible different domino faces in a normal set. In passing, it is worthwhile commenting that modern domino sets can be comprised of 28, 55, 91, 136 or 190 tiles. They are known respectively as Double 6, Double 9, Double 12, Double 15 and Double 18 sets.

In mathematical tilings, the word domino often refers to any rectangle formed from joining two squares edge to edge. The word is derived from the Latin *dominus*, meaning

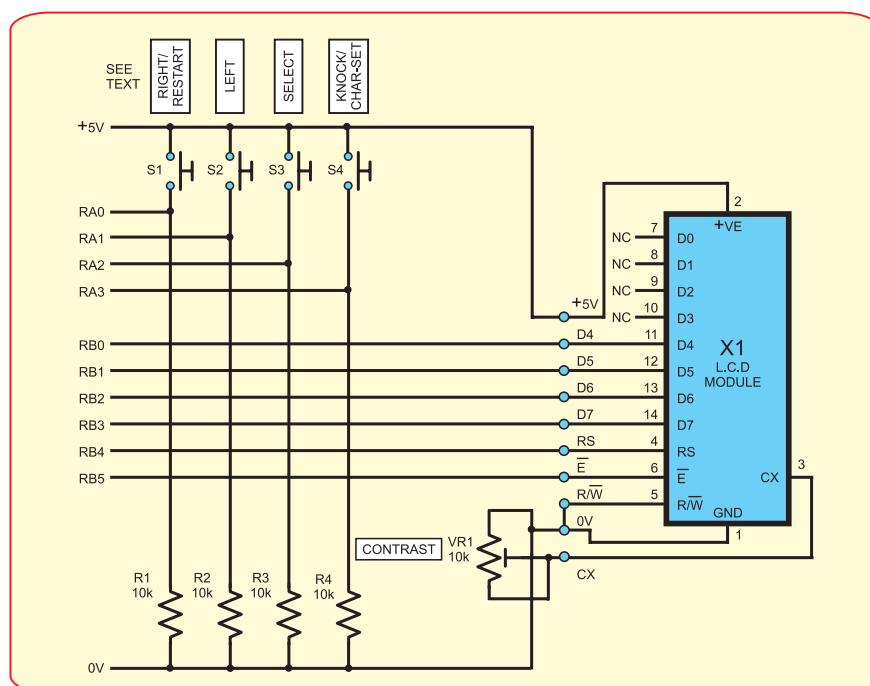


Fig.10.1. Circuit for Mock Dominoes

lord or master. The oldest domino sets have been dated back to around 1120, possibly of Chinese origin. General information on dominoes can be found at <http://en.wikipedia.org/wiki/Dominoes>.

The Basic requirements were translated into assembler for the PIC program. The author often uses QBasic (or Visual Basic) to simulate the logic of a complex routine before translating it into PIC assembler.

The QBasic routine is shown in Listing 10.1. It produces all the possible permutations of the domino face sides from 0 (blank) to 6. The routine is

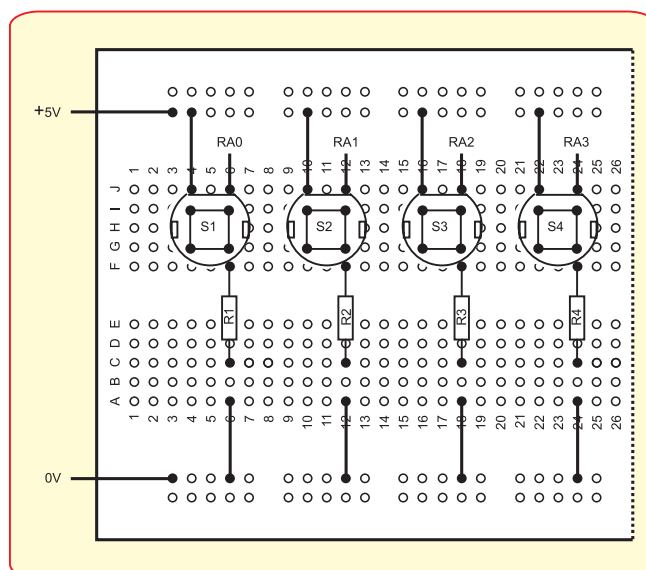


Fig.10.2. Breadboard layout for Fig.10.1

Listing 10.1

```
DIM tile$(28): b = 0: CLS

FOR c = 0 TO 6
FOR a = c TO 6
tile$(b) = LTRIM$(STR$(c)) + LTRIM$(STR$(a))
PRINT tile$(b); " "; b = b + 1: NEXT
PRINT: NEXT c: PRINT b
```

readily translatable for running through other forms of Basic. The equivalent PIC routine is in the main program at label Tilessetup.

The permutations produced are:

```
00 01 02 03 04 05 06
11 12 13 14 15 16
22 23 24 25 26
33 34 35 36
44 45 46
55 56
66
```

If you are familiar with dominoes, you will know that the tiles can have their sides swapped over, allowing '16' to be reversed to become '61', for example. Consequently, it is not necessary for a separate '61' tile to exist when there is already a '16'.

Each tile side is stored as one nibble (4 bits) of a byte (8 bits). Thus, one byte holds the information for a single tile. PICs can be told in which order they should hold their nibbles, with the command SWAPF,F, where 'F' is the address of the file whose nibbles are to be swapped.

The created tile value storage registers are allocated to be in PIC Bank 0, with an address immediately following other CBLOCK allocated register addresses, commencing at TILE0 (the other 27 tiles are not specifically mentioned as they are never called by name, but register space is allowed for them).

Random routine

Having created the 28-tile set, a randomising routine is used to allocate seven tiles to each player, ensuring that no repeats of any tile are produced. This is done by placing 'xx' into the used byte, with the software ignoring any value of 'xx'. A simple randomising routine is used and is similar to the one used earlier in the series when dice throws were being simulated. It is not totally random, but is good enough for the current process. (A more sophisticated randomising routine is described next month.)

Randomising here simply entails adding a primary number (7 in this case) to a counter each time the randomising routine is accessed. The value of the counter is then read and restricted to values below 32 before the tile selection choice is made according to the value held in the counter. Values greater than 28 are ignored. At the end of the full selection the unused tiles are also ignored in this game.

The selected tiles are stored in registers in Bank 1, commencing at h'60' for you, and at h'A0' for the PIC. Your selected tiles are displayed on LCD line 1. Those for the PIC remain hidden.

Initially, who starts the game is also subject to a randomised choice, depending on the unspecified setting of STARTER bit 0, ie bit 0 is used as a flag. (Remember that registers can take on any random value at power switch on.) The value 0 represents you, whereas 1 represents the PIC.

Assuming that the starter is the PIC, it scans its available tile values until it finds a double-sided face (in a normal domino game, the starter usually chooses the highest value of double – not so here for the PIC).

The choice of double is displayed on LCD line 2, at the left. The byte value is also stored to an incrementing storage register area (commencing at LCDStore0) in Bank 1 at h'C0'. This stores all user or PIC selected choices in order as the game progresses.

When writing the program, the author ensured that intentionally allocated registers (via the EQU instruction) started at addresses which would not cause an overlap in register allocation. He then only needed to specify the first address in each group and did not need to name each address in that group. The use of commands FSR and INDF then allows ready access to any address in a group.

Note in the ASM file how the value placed into FSR explicitly specifies the Bank as well as the register within it (ORing the register value with 128 for Bank 1, omitting the 128 OR for Bank 0).

Switch selection

When it is your turn to make a tile selection, you use switch S2 to move the highlighted double cursor across the double-byte values. Pressing S1 moves the cursor back. A single press of the switches is required for each move, holding down the switch to progressively move the cursor has been inhibited. There is a brief pause between releasing a switch and when it can be pressed again, to prevent switch bounce.

Note in the switch selection routine how a holding loop is used if no switch is pressed. In another program, this might allow the software to go off and do something else while a switch press is awaited.

When a highlighted tile has the correct face (either side) to match the right hand face of the last tile shown on line 2, press S3 to select it. It is automatically turned to face the correct way on line 2 if the order is wrong. Following selection via S3, the tile is renumbered to 'xx' so that you cannot use it again (as said, the software ignores any 'xx' tile face and does not allow its selection).

The PIC then tries to find a face value which matches the right hand side of the tile just selected.

If at any time you do not have a tile which can be played, press S4 to 'knock' in the traditional domino fashion. This sets a flag which is cleared when a tile can be played, by either you or the PIC. When a 'knock' is made, the other player then tries to find a suitable tile. If it is the PIC that cannot find a tile, then it makes an equivalent 'knock' and the display on line 2 remains the same, apart from displaying the current 'knock' value at its far right.

If neither player has a playable tile, the 'knock' flag is not cleared and the flag value increments. After four 'knocks' the software knows that the game cannot be taken further. It then calculates how many tiles each player has successfully played and shows the results on line 1, with the quantities prefixed by 'U' and 'P' respectively, followed by the indication of who has won. If the tile counts are equal, the game is a draw and the winner is shown as 'X'. The counters' tile use monitoring is incremented in BCD so that there is no need to use a binary-to-decimal routine before the respective value can be displayed meaningfully.

Once the winner has been declared, switch S1 can be pressed to start another game. The program loops and effectively 'shuffles' the tiles while reallocating a further seven to each player. You then play the next game in the same way as the first. The player who won the previous game now becomes the one to find the starting double. If a draw exists, the choice of starter is made randomly.

When several games are played consecutively, no record is kept of who has won the most. Such matters are left to you and a pen and paper!

Note how during the game, the played tiles display is truncated to only show a maximum number of tiles, ignoring the earlier ones if there are too many to show on a single line.

LCD cursor control

Throughout the game, the LCD cursor is turned on when you are the one to select a tile, but is otherwise turned off. The two commands that control this function are:

```
movlw b'00001101' ; display on, cursor
underline off, cursor blink on
call LCDLIN
```

and

```
movlw b'00001100' ; display on, cursor
underline off, cursor blink off
call LCDLIN
```

Note that any command that is sent to the LCD is always made via the LCDLIN sub-routine.

Two tile faces have to be highlighted simultaneously, and two cursor position addresses are alternately sent to the LCD, rapidly moving the highlight back and forth across a double pair by repeatedly calling routine SELECTCURSORVAL while a switch press is awaited:

```
SELECTCURSORVAL
bcf STATUS,C
rlf SELECTLOOP,W
iorlw b'10000000'
```

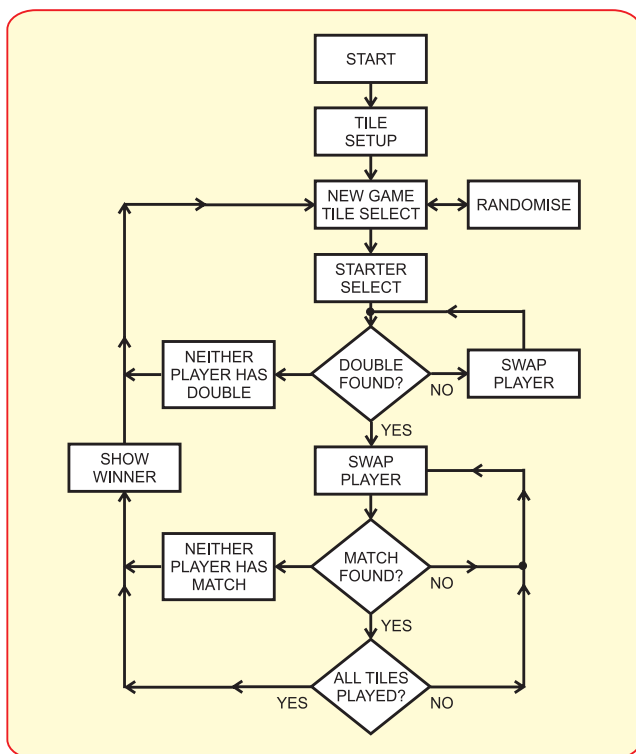


Fig.10.3. Flow chart for the game

```

call LCDLIN
bcf STATUS,C
rlf SELECTLOOP,W
iorlw b'10000001'
call LCDLIN
return
  
```

SELECTLOOP holds the address of the tile to be highlighted, which is repeatedly swapped between the LCD addresses of the two sides of the tile selected. The LCD cursor address is basically twice that of the tile register address, hence the two commands RLF SELECTLOOP,W. It is the value of the SELECTLOOP bit 0 held in W which determines the LCD address which is to be highlighted.

Tile face type

As things stand so far, the values are shown numerically. The facility to show them as traditional dots (or 'pips') has been provided. The choice of display type can be made when switch S1 is pressed and held pressed while the PIC's power

is turned on. The selection is stored in the EEPROM for use the next time S1 is pressed when the power is switched on. The choice of display type alternates on each such occasion. The value is always read from the EEPROM each time the program is switched on.

The LCD has 16 bytes available in its character generator, which can be programmed to hold symbols other than those normally provided. These are held in LCD locations 0 to 15 (see Table 3 in the Using Alphanumeric LCDs article referred to previously in the series for a list of the character generator's symbol locations).

Display command values between 0 and 15 cause the user-generated symbols to be displayed in the same way as when you use values to access symbols at the normal character locations (32 upwards).

Throughout the *Teach In* series up to this point, you have been displaying the LCD's alphanumeric character via the DisplayAddress command that is part of the LCD initialisation routine. To write your own symbols into the Character Generator RAM locations (0 to 15), the CG RAM-use command must first be given, via LCDLIN. The datasheet shows all the commands available for a standard 2-line alphanumeric LCD.

The CG RAM selection command is b'1AAAAAAA', where the 'A's indicate the CG RAM address selection. The selection is made by setting the LCD address you want to write to into 'W', and then calling LCDLIN. When writing symbol data to the CG RAM, eight writes to it are required to form a complete symbol. The CG RAM address is automatically incremented with each write, thus you only specify the first address to which you wish to start writing.

Symbol creation

To create a symbol, you draw a squared map of the pixels that make up the symbol (five horizontally and eight vertically). The maps required for the seven domino faces are shown in Fig.10.4. Note that line 8 is reserved for underline cursor use – the main character symbol is in the first seven lines.

Below each map are the logic values of each line. A '1' represents a pixel which is to become active, and '0' for one which is not. The values are shown in 5-bit binary logic. To suit them for use in the PIC program, simply add another three zeroes at the beginning of each 5-bit line and terminate the value with another apostrophe, e.g. b'00010001'.

Examine the ASM file and you will see all seven domino faces represented in the table at label CHRTABLE. The binary values are preceded by 'RETLW' to allow the table to be called and for a return to the calling point to be made with the specified value held in 'W'.

The table starts at program address (ORG) h'400'. When calling the table, you must first set a suitable PCLATH value as it is not in the normal first 256 program locations. The table is then accessed via a loop which allows the table values to be 'returned in W'. The program's routine for sending symbol data to the CG RAM is shown in Listing 10.2.

Since seven domino symbols are required, the loop is set to read and send 56 values to the CG RAM. Note that the CG RAM is volatile, and so its programmed data is lost when power is switched off, and hence the CG RAM programming routine has to be repeated each time the PIC and LCD are turned on again.

Once the CG RAM has been programmed, the symbols can be displayed by writing to the required display address (between 0 and 15) in the normal way. However, the numerical values written through LCDOUT must be no greater than the user-programmed CG RAM symbol addresses (unexpected symbols will probably appear if you use a greater value). Consequently, when displaying the symbol, the value sent via LCDOUT is not ORed with 48 to convert it to the equivalent ASCII numerical form when numbers are sent for display. The value simply specifies the CG RAM's address location at which the symbol is held. In the program the command IORLW 48 is bypassed when the user created symbol display flag (GRAPHIC bit 0) is set.

It should be noted that after finishing writing to CG RAM, a Display Address, such as that made via call LCD1 plus bsf RSLINE,4 must be sent to return the LCD to normal display mode.

More to think about

It is worth experimenting with the commands shown in the LCD command codes table, as there are other display control possibilities available. Ignore the Function Set option, otherwise you could lose control of the LCD until after switching power off and on again. The functions available through this option are partly related to the way that LCD is wired to the PIC.

00000	00000	00000	00000	00000	00000	00000
00000	00000	10000	10000	10001	10001	10001
00000	00000	00000	00000	00000	00000	00000
00000	00100	00000	00100	00000	00100	10001
00000	00000	00000	00000	00000	00000	00000
00000	00000	00001	00001	10001	10001	10001
00000	00000	00000	00000	00000	00000	00000
00000	00000	00000	00000	00000	00000	00000

Fig.10.4. LCD maps for the Domino faces

Listing 10.2

```

CHARCT    movlw b'01000000'    ; set first address for CG RAM write
          call LCDLIN
          bsf RSLINE,4
          clrf LOOPTA

          movlw 4                ; Set for sub-page 4
          movwf PCLATH

CHR       movf LOOPTA,W
          call CHRTABLE          ; get symbol data
          call LCDOUT            ; send to LCD CG RAM
          incf LOOPTA,F
          movf LOOPTA,W
          xorlw 56
          btfss STATUS,Z
          goto CHR
          clrf PCLATH            ; clear PCLATH
          return

          ORG H'400'

(CHRTABLE goes here)

```

You might also care to think what routines would need to be added and/or changed to allow two human domino players to play together. Some aspects would be simple, but others might be more complex.

And a couple of challenges – there are two minor bugs in the program. The first is that when selecting the first tile pair on LCD line 1, it is sometimes necessary to move the cursor to the second pair and then back again before the first pair can be selected. Second, the cursor position sometimes skips a pair to the next one. Can you fix these bugs?

A few helpful notes

During this series we have provided you with sufficient knowledge about the PIC16F628 to enable you to now write your own programs for your own purposes. You should be aware, though, that there are various aspects of the PIC16F628 that we have not described. Many of them the author has never used. In due course, you may find aspects that are useful.

Armed with knowledge about the PIC16F628, you now have a pretty good understanding of the basic requirements for programming any PIC microcontroller. It should be strongly noted, however, that there are other families of PICs in which some aspects are treated differently to the PIC16F628. Whatever PIC you choose to use, always obtain its datasheet before using it. As said previously, datasheets can be downloaded free from Microchip's website.

Always remember that users of our *Chat Zone* are incredibly knowledgeable about many things, and it's always worth asking there about any matters which may puzzle you.

Programming

To the uninitiated, it may seem that a software programmer simply sits down and writes all the commands in a single operation. If only it were that simple! Before a single line of code is written, there is a great deal of thought involved about the overall objective and how each step on the

way to achieving it might be performed. Part of this consideration relates not only to the logic of the software routines, but also to the control requirements of external interfaces.

There are two schools of thought about the planning. The first considers that the use of flow charts is an essential requirement. The other doesn't! The advantage of using a flow chart is that it shows the questions and answers of each stage of the program in a diagrammatic form. Theory says that this chart then enables the code to be written to meet each of the requirements illustrated.

The use of a flow chart certainly helps in concentrating immediate thought processes, and in recapturing concepts in the future, but it cannot display the command by command reasoning of each line of code. Only the code itself shows that, unless you also translate each line of code into lengthy textual comments, in which case there is the danger of getting bogged down with words.

Additionally, there is always the possibility that some logical consideration has been omitted from the flow chart and which only comes to light once you try to run the program, requiring the chart to be redrawn as well as the software having to be rewritten. The author finds that the detailed thinking about the program structure builds up as a mental flow chart, which does not require to be set down on paper.

It is acknowledged that in a commercial situation it would be mandatory for the program structure to be well documented with flow charts – the program might eventually need to be changed by someone other than the original programmer. In that case, the flow chart would give a more immediate insight into the original programmer's thought processes.

However, let us not deter you from drawing up flow charts if you prefer to do so. You may well find that they help you to grasp what you are doing more readily than just relying on your mental 'visualisation' processes.

To discuss flow charts more fully is beyond the scope of this tutorial (although

a simple example is given in Fig. 10.3, but created in retrospect rather than prior to the program being written). You will also find examples of them in Microchip's application notes. It has to be said, though, that even in those, which are full of program listings, flow charts are not widely used. Mike Hibbett also looked at the subject in *PIC n' Mix*.

Stage-by-stage

Whether or not you use flow charts, you should never attempt to write the entire program from beginning to end in one operation. That way can lead to extensive problems when you try to debug the program having found that it doesn't do what you expected.

Take each routine stage-by-stage. Get one small section of code working before you move onto the next. Then get that next small section working before you try to join it to the previous part. 'Be methodical' is the key command when programming.

As you get further into PIC programming, you may decide that you would like to write code in conjunction with a simulation program. These help you to debug code on your PC before downloading it to the PIC. Such programs will not replace the thought processes needed when writing code, but they will let you find many (but not all) of the errors more quickly.

However, the author finds it very easy to check program operation when the code is in the PIC and the PIC is connected to its various interfaces. Had the PIC16F628 not been an EEPROM device, then this would not be an acceptable technique, but it is rapidly reprogrammable and so is usable as a live test-bed.

One further point, when writing a program the author finds it useful to supplement its software file name with a suffix number, increasing the number at each save of a major addition or change to the previous code written. This allows an earlier version to be recalled should the need arise, for example, PICIT01.ASM, PICIT02.ASM, PICIT03.ASM, etc.

PICs versus hardware

Although microcontrollers can be enormously beneficial, there is the likelihood that it may be regarded by the inexperienced as the ultimate answer to all electronic circuit design. This is most definitely not the case. All that a microcontroller will do is assist in using software commands to replace a fair number of operations for which many electronic components would otherwise be needed. It cannot substitute for all electronic requirements.

There are also situations in which a microcontroller *can* be used, but it is not necessarily desirable that it should. What you will discover as you get further into programming, is that the act of programming a PIC to replace a given number of logic chips can take far longer than if you were to design a circuit that performed the same function but only used such chips. Unless you actually *want* to get a PIC to do something because it *can*, and you see it as a challenge, always ask yourself if the additional development time is worth it in order to save a chip or two.

Software writing generally

When writing software, you will find much frustration through the inability to immediately see the bug in a program routine. Eventually, though, you will spot it and the relief and exhilaration of at last getting that part to work is enormous. In that frame of mind, you will move on to writing the next sub-routine with the utmost confidence and anticipation of not making a mistake on *this* one. Would that it were so! You can, and you will, make

mistakes. But the ultimate satisfaction of a complete working design makes it all worthwhile.

If you can't take occasional bouts of desperation, isolation from friends and family, followed by periods of ecstasy and feelings of well-being towards all humanity, leave programming alone. The author, though, has become a 'programming-addict' and thrives on the challenges, come what may!

But always remember that Murphy's Law has its most powerful influence

when programming is involved. If the microcontroller or other computer *can* misunderstand what you *mean* by your commands, it *will*. It is up to you to see the way in which each and every one of your commands will *actually* be interpreted. You are the intelligent one, the computer simply obeys your instructions!

Next month, in the concluding part of Teach In 2008 we present a short discussion on sophisticated randomising and a practical example of it in use.

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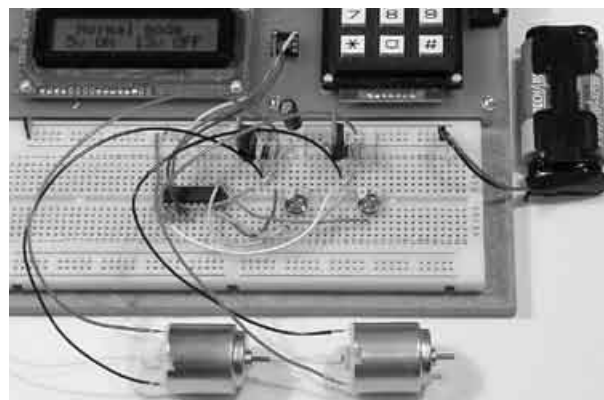
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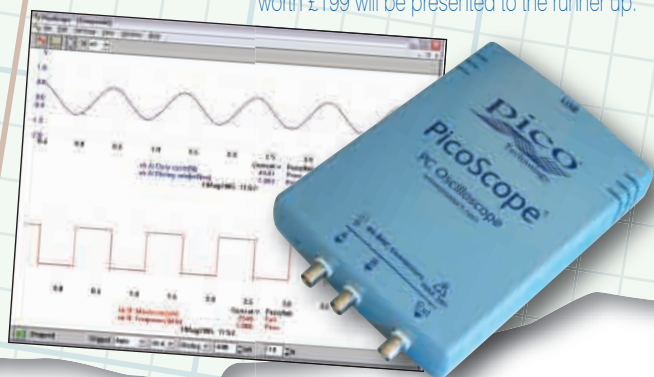
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Universal Ding-Dong – No more chimes blues?

So you found those chimes at an antiques fair, and would like to use them as a ding-dong doorbell. Or you bought those gongs at a market in Asia, but can't work out how to wire them to the pushbutton on your patio. Here's the solution, in Fig.1. The circuit activates two solenoids in sequence, to strike two chimes or gongs – one when your doorbell is pressed, the other when it is released.

When pushbutton S1 (the front doorbell) is first pressed, C2 instantly charges. This

prevents switch bounce, which might cause solenoid L2 to trigger prematurely (L2 is likely to activate briefly on power-up). IC1a and IC1b form a positive-edge-triggered monostable timer, so that when pins 1 and 2 go high, TR1 conducts for a fraction of a second, activating solenoid L1. Diode D1 suppresses back-EMF, which could destroy IC1 in particular. When pushbutton S1 is released, C2 discharges through R1.

IC1c and IC1d, with TR2, form a positive-edge-triggered monostable timer, so

that when pin 8 goes low, TR2 ceases to conduct. This means that TR3's gate goes high, and TR3 conducts, thus activating solenoid L2 for a fraction of a second. D2 is again provided to suppress back-EMF.

Unless a large battery is used for B1, C1 is needed to provide the 'whack' required for solenoids L1 and L2. Non-polarised capacitors are recommended for C2 to C4, to set aside worries about polarity. However, polarity is shown in the circuit in case the constructor is only able to

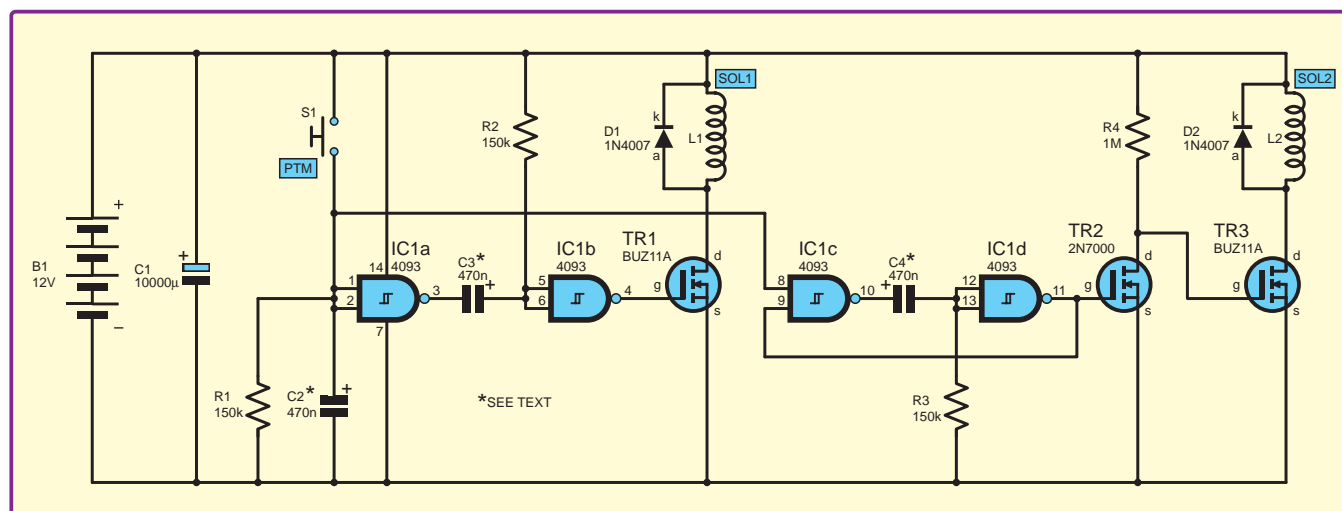


Fig.1. Circuit diagram for the Universal Ding-Dong

locate electrolytic capacitors of this value. If the pulses which activate L1 and L2 are not sufficiently long, the values of R2 and R3 may be increased, and vice versa.

If TR1 and TR3 cannot be found, rough equivalents may be used. Equivalents should be chosen with care for TR2, since this is a miniature MOSFET. While an NPN bipolar transistor could be used here, the value of R4 should then be reduced to, say, 47k Ω , thus increasing power consumption on standby.

Ideally, solenoids L1 and L2 are 12V push-action types, or pull-action types which have a thrust pin at the back.

However, plain pull-action types should work if they are touching the chimes or gongs when the circuit is at rest (they would then pull back, bounce, and strike). Small motors with hammers attached may also be used, with suitable series resistors if required.

On standby, the circuit draws a mere 20 μ A of power. This can be reduced by increasing the value of R4 (the author successfully tried 10M), or by replacing R4 and TR2 with a CMOS inverter. However, AA batteries should be able to provide 20 μ A continuously for several years.

Thomas Scarborough,
Cape Town, South Africa

10V to 12V LED Voltmeter – Bargraph metering

THE CIRCUIT shown in Fig.2 was built to monitor the voltage of a car battery during its charge-discharge cycle. The LED 'bars' light up in roughly in 1V volt increments,

Below 10V, Zener diode D16 does not conduct sufficiently to forward bias the base of transistor TR1, so no collector current flows. As the input voltage increases above 10V TR1 starts to conduct, passing collector current through the LED array and resistor R2.

The current flowing through R2 reduces the voltage across the Zener diode, keeping its cathode at a constant 10V. The value of R2 therefore determines the 'amps per volt' passing through the LED array, ie the meter sensitivity – a value of 100 Ω gives a LED array current of 10mA per volt above 10V input voltage.

As the current through the LED array increases from zero, the first LED to light up is D1. When the current increases to around 10mA, the voltage developed across resistor R3 is about 2V, so the second LED bar (D2 and D3) starts to light up. At around 20mA, the voltage across R4 has reached about 2V, so the third LED bar (D4, D5 and D6) starts to light up. At around 30mA, the voltage across R5 has reached about 2V, so the fourth LED bar (D7 to D10) starts to light up. Finally, when the current reaches around 40mA, the voltage across R6 is about 2V, so the fifth LED bar (D11 to D15) starts to light up.

The total current consumption at 15V input is about 50mA. For best results use LEDs with a forward voltage drop of 2V or less at 10mA and low internal resistance.

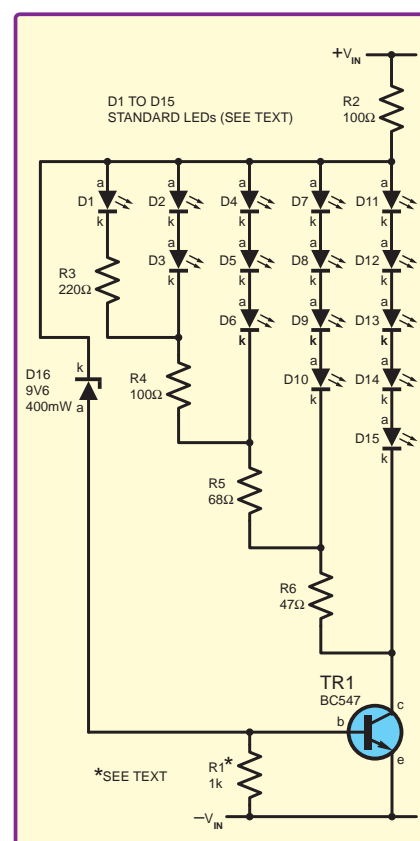


Fig.2. Circuit diagram for the 10V to 12V LED Voltmeter

To 'fine tune' the Zener diode voltages try varying the value of R1, but do not go below 100 Ω or above about 47k Ω .

P.A. Tomlinson,
East Yorkshire



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Transistor Saturation

IN the June '08 *PIC N' Mix* feature, John Becker discussed a problem that reader **John Pugh** was having with a circuit. The circuit in question used a PIC to drive a multiplexed LED display, which unfortunately suffered from variable brightness, depending on the number of segments lit. If only one or two segments were lit the LEDs were very much brighter than when more segments were on. The *PIC N' Mix* article concentrated on diagnosing the problem – what was the fault? It could be the display, the transistors, or the software.

John suggested some diagnostic tests and eventually the reader replaced the anode transistors with Darlington devices and the problem was solved. Following on from that; this month's *Circuit Surgery* will focus on using transistors as switches, covering some basic concepts concerning the saturated and non-saturated operation of bipolar transistors. We then analyse the LED drive circuit and thankfully arrive at the same conclusion as last month's practical approach.

In Fig.1 is shown the circuit discussed in June's *PIC N' Mix*, only one digit and two segments are shown here, but the full circuit has six 'digit switch' transistors (Q2) connected to the common anodes of each 7-segment display. Each display has eight LEDs (seven segments and a decimal point). The cathodes connect to the 'segment switch' transistors (Q1a, Q1b etc). This circuit contains transistor switches using

both common emitter (Fig.2) and emitter follower (Fig.3) circuit configurations. We will look at these separately before tackling the full LED multiplexing circuit.

Saturation

When using a transistor as a switch, it is usual to want the transistor to go into *saturation*. This is opposite to analogue (linear) amplifiers, where normally we would want to avoid saturation, as it would probably imply clipping of the signal.

Saturation is characterised by a small voltage drop between the collector and emitter (called V_{CESAT}), which is typically around 0.1 to 0.2V. From Fig.2 and Fig.3 it is clear that most of the supply voltage will appear across the load (R_L) if the transistor is saturated.

At this point it is worth noting that we are discussing bipolar junction transistors (BJTs) here and not field effect transistors (FETs). The term saturation is also used for FETs, but has a different meaning.

In saturation, the collector to emitter voltage across a bipolar transistor does not vary much with varying collector current, so we apply a more or less constant voltage to the load, which is usually what we want. However, as we have discussed in recent *Circuit Surgery* articles, LED brightness is actually dependent on current rather than forward voltage drop.

The circuit in Fig.1 does not apply constant current to the LEDs directly, so it will not guarantee a perfect brightness match against *individual LED variation*. However, this is not the specific issue of concern here.

If we assume the LEDs in a display are reasonably well matched, a stable voltage across the LED and resistor combination of each segment is adequate. This voltage, that is the voltage between points E2 and C1a, C1b etc in Fig.1, needs to be constant because the number of LEDs which are on varies. We can analyse the circuit to see if this happens, but in order to do this we have to know the region of operation for the transistors.

Table 1: Bipolar transistor regions of operation

Base-emitter junction bias	Base-collector junction bias	Region of operation	Comment
Forward	Forward	Saturation	Switch ON
Forward	Reverse	Reverse active	Poor amplifier, specialist uses
Reverse	Forward	Forward active	Good amplifier
Reverse	Reverse	Cutoff	Switch OFF

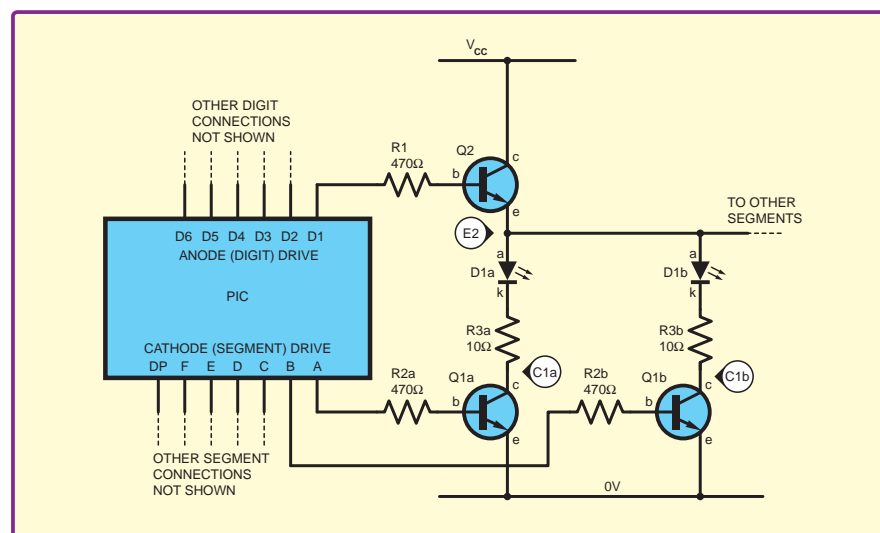


Fig.1. Part of the seven-segment LED driver circuit. Only two segments of one digit are shown

The properties of a transistor in saturation are different from those in what is called the active region of operation. It is the *active region* which is usually used for amplifiers, and here we have the familiar situation of the collector current being equal to the base current times the gain (typically one or two hundred times).

The transistor contains two diode (PN) junctions, this is true of both NPN and PNP transistors; the junctions are simply the opposite way in the two types, requiring opposite voltages for the same operation. The two junctions can be either forward biased (on) or reverse biased (off) so there are actually four different regions of operation for the transistor. These are shown in Table 1.

When a transistor is used as a switch it is usually switched between the saturation and cutoff regions. In the cutoff region, both junctions in the transistor are reverse biased and no current flows through the transistor

(except some leakage). In the saturation region, both junctions are forward biased, so each junction will have about 0.7V across it. For example, we might have $V_{BE} = 0.75V$ and $V_{BC} = 0.70V$, the collector to emitter saturation voltage (V_{CESAT}) will be the difference between these, in this case 0.05V.

As we have already said, the forward active region is used for amplifiers. The base-emitter junction will be forward biased with typically around 0.7V across it (V_{BE}), which is slightly lower than the saturation case. The collector to emitter voltage (V_{CE}) will typically be a few volts, so the base-collector junction will be reverse biased by this value minus V_{BE} . The *reverse active* region is not commonly used but does have some applications in some types of logic and analogue switching circuits.

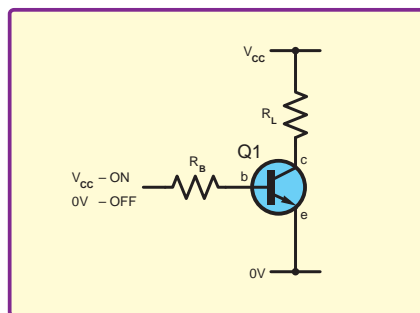


Fig.2. A switch using a BJT (bipolar junction transistor) in common emitter configuration

Current gain

An important characteristic of the transistor in the forward active region is the current gain, or strictly speaking the *forward current gain*. This is the familiar transistor 'gain' and has the symbol β (β_F) or h_{FE} . In the forward active region the collector and base currents are related by the well known relationships

$$I_C = \beta I_B \text{ and } I_B = I_C / \beta$$

These are simple and useful equations, *but they do not apply in the saturation region*. For a transistor in saturation, the base current is greater than I_C / β . In fact, the base current exceeding I_C / β can be regarded as a condition for saturation. The value of I_C / I_B in saturation is called the *forced beta*, β_{FOR} .

An example will hopefully clarify how we make use of these ideas. Let's say we want to use the circuit in Fig.2 to supply 100mA to the load resistor (R_L) using a suitable transistor (in terms of current rating). Assume the transistor has a typical gain of 100 (ie $\beta = 100$) and that the supply is 5V. We might proceed as follows.

If we assume a very small collector-emitter voltage and ignore this, then there is 5V across the resistor. To limit the current to 100mA in this situation we need a resistor value of 50Ω ($R_L = V / I = 5 / 0.1$). If we use $I_B = I_C / \beta$ we get $I_B = 0.1 / 100 = 1mA$. If we assume that V_{BE} is 0.7V to get 1mA base current we need $R_B = V / I = (5 - 0.7) / 0.001 = 4.3k\Omega$.

The problem with this is that transistor gain is actually quite variable, under different conditions (current, temperature) and importantly between individual transistors. So our assumption that the gain is 100 is likely to be wrong. If the gain was actually only 70 we would only get approximately

70mA through the load, far less than we expected. The assumption that collector-emitter voltage is very small would also be wrong; it would actually be about 1.5V.

Now let's look at the same circuit gain, but this time making sure the transistor is in saturation. Unlike the actual beta we can choose a forced beta, let's say ten times smaller than the nominal value, that is $\beta_{FOR} = I_C / I_B = 10$. So with all else the same as above we need a base current of 10mA for which $R_B = V / I = (5 - 0.7) / 0.01 = 430\Omega$.

Note that this value is similar to the one used for R2a, R2b etc in Fig.1. Now, if our transistor gain is 70 rather than 100 we still get 10mA in the base and 100mA through the LED and a small collector-emitter voltage. The forced beta is only seven times less than the actual beta, rather than ten times as we designed, but the factor of ten has given us plenty of 'margin for error' in making sure the transistor is saturated.

If we change the load resistance in the circuit in Fig.2, for example we halve or double R_L , the transistor remains in saturation. The voltage across the load therefore remains almost constant with a large load variation. We will use $\beta = 100$, $I_B = 10mA$, $R_B = 430\Omega$ as above. If V_{CESAT} is around 0.1V we can approximate the voltage across R_L to exactly 5V to keep things simple. For $R_L = 25\Omega$ (load halved) I_C is 200mA and the forced beta is 20, confirming saturation. For $R_L = 100\Omega$ (load doubled) I_C is 50mA and the forced beta is 5, again confirming saturation.

Looking at Fig.1, which also has a supply voltage of 5V, we can find the approximate base current for Q1a, Q1b etc using $I_B = V / R = (5 - 0.7) / 470 = 9mA$. The maximum LED current (pulsed) stated in *PIC n' Mix* is 160mA so 9mA gives a forced beta of around 18, so the segment transistors should be saturated (assuming the gain of the transistors used is much higher than 18).

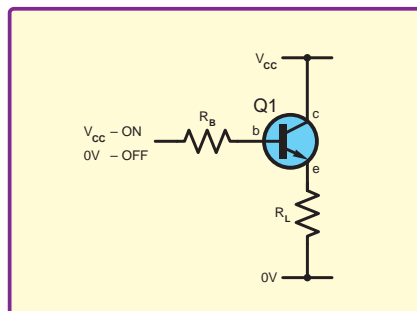


Fig.3. Switch using a BJT in emitter follower configuration

Approximate voltages

Moving to Fig.3, to look at the emitter follower transistor, we can work out some approximate voltages. If we assume the transistor is in the active region with $\beta = 100$, a collector current of 100mA, a base current of 1mA, then what is the voltage at the emitter and hence across the load? We might immediately assume that it is one V_{BE} drop below the supply, at 4.3V (ie $5 - 0.7$, assuming $V_{BE} = 0.7V$). However, this ignores R_B which drops 0.47V with 1mA through it. So the emitter voltage would be $5 - 0.47 - 0.7$, which is about 3.8V. This gives 100mA load current (and hence collector current) with $R_L = 38\Omega$ as the load.

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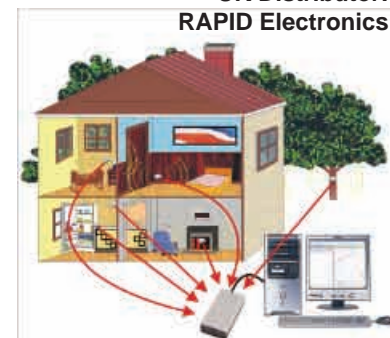


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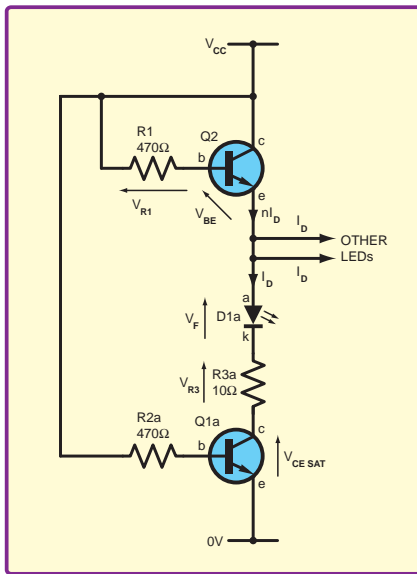


Fig. 4. Analysis of the LED multiplexer circuit

The resistor and V_{BE} drops in the circuit in Fig. 3 ensure that the emitter is at least a volt or so below the supply, so the base-collector junction will be reverse biased and the transistor will be in the forward active region. Reducing the base resistor to try to produce a high base current beyond I_C/β will not work in the way it did for the common emitter circuit in Fig. 2.

If we make R_B ten times smaller at 47Ω we get a collector current of 112mA and a base current of $112/100 = 1.12\text{mA}$. The voltage drop across R_B is 0.053V ($47 \times 1.12\text{mA}$) so the emitter voltage is $5 - 0.052 - 0.7 = 4.247\text{V}$ (assuming V_{BE} is 0.7V). This gives the current through the load of $4.247/38 = 112\text{mA}$. A tenfold change in base resistor has had relatively little effect on base current (12%) and the transistor is still in the forward active region.

Now we can see what happens when the load resistance varies. Remember that the common emitter circuit with the saturated transistor (Fig. 2) delivered more or less the same voltage across the load as we doubled and halved its value. For the emitter follower we will use $R_B = 470\Omega$ and $\beta = 100$ as above. For $R_L = 19\Omega$ (load halved) we have approximately $V_L = 3.4\text{V}$, $I_L = 182\text{mA}$, $I_B = 1.82\text{mA}$. The voltage drop across R_B is $470\Omega \times 1.82\text{mA} = 0.86\text{V}$, giving the load voltage of $5 - 0.86 - 0.7 = 3.4\text{V}$. For $R_L = 76\Omega$ (load doubled) we have approximately $V_L = 4.05\text{V}$, $I_L = 53\text{mA}$,

$I_B = 0.53\text{mA}$. The voltage drop across R_B is $470\Omega \times 0.53\text{mA} = 0.25\text{V}$, giving the load voltage of $5 - 0.25 - 0.7 = 4.05\text{V}$.

Unlike the common emitter circuit, doubling and halving the load resistance has caused a significant change in load voltage. This voltage change is due to the drop across the base resistor changing as the base current changes. This circuit is not really a very good switch.

Analysis

The previous discussion has given some insight into transistor operational regions and the switching properties of the two configurations used in Fig. 1. The change in load voltage observed for the emitter follower transistor leads us to suspect that this might be responsible for the LED brightness variation described in the *PIC N' Mix* feature. We can confirm this by some further circuit analysis.

Fig. 4 shows one digit and one segment from Fig. 1 (with the segment on), and labels for the voltage drops in the circuit. The total of these voltage drops from ground to supply is equal to the supply voltage. So $V_{CC} = V_{CESAT} + V_{R3} + V_F + V_{BE} + V_{R1}$. Where V_F is the forward voltage drop of the LED, which we will assume to be about 2V .

Note that the LED current in each 'on' segment is I_D . For simplicity, we assume the components in each segment are exactly the same, so all the LED currents are equal. The individual segment currents flow separately through the segment switch transistors Q1a, Q1b etc, but for each digit they combine to all flow through the digit switch transistor (Q2 in Fig. 4). So if n segments are on, then Q2's collector current is nI_D .

The resistor voltage drops are dependent on the LED current:

$$V_{R1} = I_{B2}R1 = nI_D R1/\beta$$

$$V_{R3} = I_D R3a$$

Substituting these in the above equation we get:

$$V_{CC} = V_{CESAT} + I_D R3a + V_F + V_{BE} + nI_D R1/\beta$$

Rearranging this equation to make I_D the subject we get:

$$I_D = (V_{CC} - V_{CESAT} - V_F - V_{BE}) / (R3a + nR1/\beta)$$

If $V_{CC} = 5\text{V}$, $V_{CESAT} = 0.1\text{V}$, $V_F = 2\text{V}$, $V_{BE} = 0.7\text{V}$, $R3a = 10\Omega$, $R1 = 470\Omega$ we can plug some values in to get a formula for this specific circuit.

$$I_D = 2.2 / (10 + 470n/\beta)$$

We see from this equation that the LED current is dependent on the number of LEDs which are on. As n increases I_D decreases, so the LEDs get dimmer when more of them are on. This was observed with the problem circuit. If $\beta = 100$ we get the following values for I_D :

- 1 LED 150mA
- 2 LEDs 115mA
- 3 LEDs 91mA
- ...
- 8 LEDs 48mA

These values confirm that our assumption that Q1a is saturated is true with a forced beta ranging from about 17 to 5. Similarly, a check of circuit voltages confirms active region operation for Q2. It is important to check assumptions about transistor operating regions once a calculation is complete to check that the assumptions were valid.

The equation for I_D tells us that the larger the gain of the digit switch transistor the smaller the dimming effect will be. Thus, when the digit drive transistor is replaced with a Darlington pair, the gain increases considerably and the effect of the number of LEDs on I_D decreases. The Darlington introduces an extra V_{BE} drop, reducing the 2.2 in the formula to 1.5, so we have

$$I_D = 1.5 / (10 + 470n/\beta)$$

If $\beta = 5000$ we get

- 1 LED 149mA
- 2 LEDs 147mA
- 3 LEDs 146mA
- ...
- 8 LEDs 140mA

Roughly the same current, but considerably less variation with the number of LEDs.

Our analysis has not attempted to calculate exact values for the real LED multiplexer; we have assumed typical values rather than trying to use specific ones. Knowing the exact transistor gains is very difficult anyway. The BC548s should have a higher gain than 100, but their gain drops rapidly for collector currents above 100mA . This would exaggerate the dimming problem.

Our analysis has confirmed the findings reported by John and, hopefully, provides some insight into transistor switch operation.



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More on I/O port expansion

This month we finish off last month's coverage of I/O port expansion with a practical demonstration – interfacing a PIC to a panel of 1024 LEDs, arranged in a 32 by 32 grid. While this is only a theoretical discussion – the author didn't sit down and wire up over a thousand LEDs – the software has been fully developed and prototyped with a few tens of LEDs to confirm the principle is practical. Panels made with a large number of LEDs find all kinds of uses, from Christmas decorations to art installations, so it is a valuable example.

Using the example of a display panel allows us to simultaneously cover another interesting topic, *multiplexing*.

Multiplexed displays

When constructing a display with a huge number of LEDs, it isn't practical to wire each LED to its own individual I/O pin. It's possible of course, but not desirable, as you will have to find 1024 I/O signals from somewhere. *Multiplexing* is a technique that allows many LEDs to share a single output pin, but still be individually controllable. The principle of the technique is shown in Fig.1. Here, a panel of 25 LEDs arranged as an array of five by five is controlled by only 10 processor output pins. Conceptually, you turn on a single row of LEDs by turning on its control signal (a single wire connected to Port B in this example) and immediately place the values that you want to see (low for off, high for on) onto the five data outputs of Port A.

Now comes the clever bit – you then turn off the row signal, turn on the control signal for the next row down, and output the data that you want to appear on that line of LEDs; and continue *ad infinitum*. Do this fast enough and the eye will not be able to see fact that you are only actually displaying one row of LEDs at a time.

Persistence of vision

This trick works because the eye takes several milliseconds to detect that the light has been turned off, an effect that is referred to as *persistence of vision*. The eyes rely on a chemical reaction to detect changes in light level, and so we can switch off the light from one row of LEDs, illuminate all the others and so long as we return back to this row quickly enough and turn it back on, the eye will not notice. This trick is how televisions and computer monitors work, and also how LED 'Message Wands' can display a message seemingly in the air. We can apply the same trick.

Before we look at the circuit design, we have to decide what kind of display update

rate to use – how quickly are we going to move from one row to another? Oddly enough, we have to be careful to not go too fast. Even before we have written the software, we know that it will take a certain amount of time to turn the signals on or off. Suppose for a moment that you could do it in 10µs. If you then moved immediately to the next row, the LED would not be switched on long enough for our eye to even register the fact before we are turning it off and illuminating the next row of LEDs. We have to provide a delay to allow sufficient time for the LEDs to show the information we have written to them and for that data to register on our eyes. So what rate is best?

Ideally, we should go as slow as possible, but no slower! Slow enough that the data has plenty of time to be visible, but not so slow that the display appears to flicker due to the time it takes to completely refresh the entire panel. Computer monitors typically operate at a 60Hz to 80Hz refresh rate. In our example, we will run slightly less than this, 30Hz. That is to say, each row will be re-drawn 30 times a second. This produces a slight flicker, but as you will not be viewing documents using this panel, it will not be a problem, and we do not over burden our processor.

With a display panel of 32 × 32 LEDs, a refresh rate of 30Hz means that each row must be displayed for approximately 1ms. Until we have written the software, we will not know just how long it will take to write the information to the display, but we now know that we must add a small delay after writing each row to ensure that the time between displaying each row is 1ms. (In fact, it takes about 400µs at 32MHz to perform all the actions required to update a row of data. Therefore, the delay routine in this example consumes about 600µs, to give an overall time of 1ms.)

Circuit

The circuit diagram for the multiplexed LED panel is shown in Fig.2. Now, we can

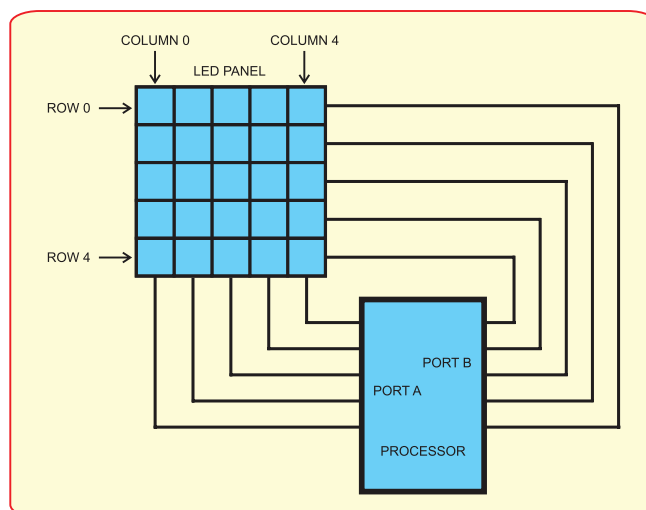


Fig. 1. Logical connections between a processor and a multiplexed display

see where the port expander ICs come in handy. This circuit requires 64 output pins to drive the 1024 LEDs. Those output pins are provided by four MCP23S17 port expander chips. The PIC that is performing all of the actual logic and timing for this example program requires only four signals to drive these chips: A single chip select signal \overline{CS} that enables all four devices simultaneously, plus the three standard SPI signals: **SCK**, **SDI** and **SDO**.

The controlling microcontroller is a PIC18F2520, chosen simply because it was to hand, and works with the PicKit2 debugger. No oscillator circuit is shown on the diagram – none is needed, as for simplicity we are using the internal oscillator of the PIC device, and configured it to run at 32MHz. It's not a high accuracy oscillator, but for this circuit it doesn't need to be. If you are using a processor that does not have a high speed internal oscillator then just use an external one as normal. It will, however, need to run at a minimum of 30MHz.

The MCP23S17 has a reset input, and we have wired all four chips up to a single resistor-capacitor reset circuit. We could have connected it to the processor reset input, but if you want to keep the port expander part of your design on a separate circuit board, it's better to keep the reset circuits separate too, to protect them from electrical noise.

Each chip has its own unique address configured on the A0, A1 and A2 lines. The software needs to know what these addresses are, obviously, but the actual values you set are irrelevant. Just make sure

much dimmer than when driving them directly. This is simply because you are only turning the LED on for about 1/30th of the time compared to when it is on all the time. This can make choosing the series resistor for each LED difficult. You don't really want to be doing a trial and error experiment on 1024 LEDs! (See this month's *Circuit Surgery*.)

Software

The software that accompanies this article can be found in the Download Area of the *EPE* website under *Pic n' Mix*. The code consists of the low-level SPI access routines, based largely on a previous article, and the control code that performs the actual display multiplexing through the port expander ICs. The control code is just 140 instructions long, demonstrating how simple the application is.

The low level SPI functions are implemented in two functions, `TX_SPI` and `TXRX_SPI`. `TXRX_SPI` is a standard SPI 'driver' routine, which can provide both the transmit and receive functionality. `TX_SPI` is a 'transmit only' version, which has been implemented to help make the code for updating the display as fast as possible.

The two functions `MCP23S17WriteByte` and `MCP23S17ReadByte` build on top of `TXRX_SPI` to provide the actual port

expander device-specific functionality. With these two routines, you can configure and use the `MCP23S17` device at an *abstracted level* – ie, you need only think about device register numbers and data to write/read in them. You can forget about how the chips are wired, and the intricacies of the SPI bus – `TXRX_SPI` handles all that for you.

The control application software assumes that you have stored a bit-map image that you want to display on the LED panel in the 128 bytes of `BANK1` RAM inside the `PIC18F2520`. Four consecutive bytes (32 bits in total) represent the status of the LEDs on a single row, with the most significant bit in the first byte being the top left LED, and the least significant bit in the last byte being the bottom right LED.

The operation of the main loop in the program performs the following actions:

- 1) Turn off the LEDs in the current row
- 2) Select the next row of the display
- 3) Read the data for the current row out of the image buffer memory, and place on the display
- 4) Wait for 1ms
- 5) Goto 1

When the software reaches the last row on the panel, it simply loops back to the top.

This approach works fine for static images. If you want to display animations you will need to decide when you do the processing to perform the update to the image buffer. The simplest solution is to change the entire image during the 1ms delay after showing the last, bottom row. An alternative, however, is to update each row in the image buffer one at a time during the 1ms delay for that row. Which method you use will depend on where you are fetching your new data from, and how quickly you can get it.

Each 'image' is only 128 bytes in size. When you consider that this entire program is only 588 bytes out of a possible 66584 flash memory locations, you have plenty of scope for storing a complex animation in flash memory. In 66000 bytes you can store over 500 images – which would make for quite a long animation, assuming you have the skills and patience to create them! This author is looking at the feasibility of using software to convert short sequences of video into 32×32 pixel, monochrome picture stills. We will report back on the progress of this, and how well the panel works, when construction is complete.

The software has been developed in `MPLAB` and is targeted towards the `PIC18F` family of parts, and the `PIC18F2520` in particular. It should not be difficult to move to a different processor, although it will require care if moving from the `PIC18F` family.

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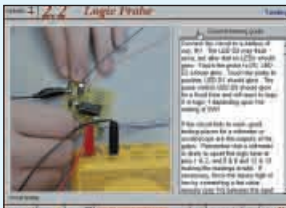
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ELECTRONICS PROJECTS



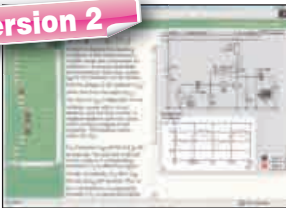
Logic Probe testing

Electronic Projects is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK schematic capture, circuit simulation and p.c.b. design software is included.

The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

ELECTRONIC CIRCUITS & COMPONENTS V2.0

Version 2

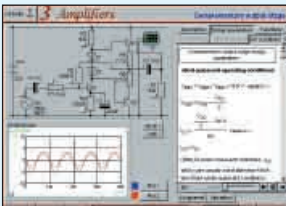


Circuit simulation screen

Electronic Circuits & Components V2.0 provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Version 2 has been considerably expanded in almost every area following a review of major syllabuses (GCSE, GNVQ, A level and HNC). It also contains both European and American circuit symbols. Sections include: **Fundamentals**: units and multiples, electricity, electric circuits, alternating circuits. **Passive Components**: resistors, capacitors, inductors, transformers. **Semiconductors**: diodes, transistors, op amps, logic gates. **Passive Circuits**. **Active Circuits**. **The Parts Gallery** will help students to recognise common electronic components and their corresponding symbols in circuit diagrams.

Included in the Institutional Versions are multiple choice questions, exam style questions, fault finding virtual laboratories and investigations/worksheets.

ANALOGUE ELECTRONICS



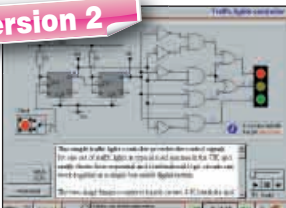
Complimentary output stage

Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.

Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections), Transistors (4 sections), Waveshaping Circuits (6 sections). **Op Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

DIGITAL ELECTRONICS V2.0

Version 2

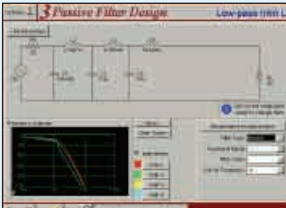


Virtual laboratory - Traffic Lights

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (above), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.

Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units. Sections on Boolean Logic and Venn diagrams, displays and chip types have been expanded in Version 2 and new sections include shift registers, digital fault finding, programmable logic controllers, and microcontrollers and microprocessors. The Institutional versions now also include several types of assessment for supervisors, including worksheets, multiple choice tests, fault finding exercises and examination questions.

ANALOGUE METERS



Filter synthesis

Analogue Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev op.amp filters.

BOGOF

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ELECTRONICS CAD PACK

PCB Layout

Electronics CADPACK allows users to design complex circuit schematics, to view circuit animations using a unique SPICE-based simulation tool, and to design printed circuit boards. CADPACK is made up of three separate software modules. (these are restricted versions of the full Labcenter software.) **ISIS Lite** which provides full schematic drawing features including full control of drawing appearance, automatic wire routing, and over 6,000 parts. **PROSPICE Lite** (integrated into ISIS Lite) which uses unique animation to show the operation of any circuit with mouse-operated switches, pots, etc. The animation is compiled using a full mixed mode SPICE simulator. **ARES Lite** PCB layout software allows professional quality PCBs to be designed and includes advanced features such as 16-layer boards, SMT components, and an autorouter operating on user generated Net Lists.

ROBOTICS & MECHATRONICS



Case study of the Milford Instruments Spider

Robotics and Mechatronics is designed to enable hobbyists/students with little previous experience of electronics to design and build electromechanical systems. The CD-ROM deals with all aspects of robotics from the control systems used, the transducers available, motors/actuators and the circuits to drive them. Case study material (including the NASA Mars Rover, the Milford Spider and the Furby) is used to show how practical robotic systems are designed. The result is a highly stimulating resource that will make learning, and building robotics and mechatronic systems easier. The Institutional versions have additional worksheets and multiple choice questions.

- Interactive Virtual Laboratories
- Little previous knowledge required
- Mathematics is kept to a minimum and all calculations are explained
- Clear circuit simulations

PRICES

Prices for each of the CD-ROMs above are:
(Order form on third page)

Hobbyist/Student	£45	inc VAT
Institutional (Schools/HE/FE/Industry)	£99	plus VAT
Institutional 10 user (Network Licence)	£249	plus VAT
Site licence	£499	plus VAT

(UK and EU customers add VAT at 17.5% to 'plus VAT' prices)

PICmicro TUTORIALS AND PROGRAMMING

HARDWARE

VERSION 3 PICmicro MCU development board

Suitable for use with the three software packages listed below.

This flexible development board allows students to learn both how to program PICmicro microcontrollers as well as program a range of 8, 18, 28 and 40-pin devices from the 12, 16 and 18 series PICmicro ranges. For experienced programmers all programming software is included in the PPP utility that comes with the development board. For those who want to learn, choose one or all of the packages below to use with the Development Board.

- Makes it easier to develop PICmicro projects
- Supports low cost Flash-programmable PICmicro devices
- Fully featured integrated displays – 16 individual I.e.d.s, quad 7-segment display and alphanumeric I.c.d. display
- Supports PICmicro microcontrollers with A/D converters
- Fully protected expansion bus for project work
- USB programmable
- Can be powered by USB (no power supply required)

£40 OFF Buy the Development Board together with any Hobbyist/Student or Institutional versions of the software CD-ROMs listed below and take £40 off the total (including VAT) price.



£158 including VAT and postage, supplied with USB cable and programming software

SOFTWARE

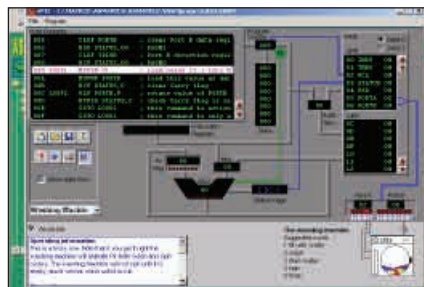
ASSEMBLY FOR PICmicro V3

(Formerly PICtutor)

Assembly for PICmicro microcontrollers V3.0 (previously known as PICtutor) by John Becker contains a complete course in programming the PIC16F84 PICmicro microcontroller from Arizona Microchip. It starts with fundamental concepts and extends up to complex programs including watchdog timers, interrupts and sleep modes.

The CD makes use of the latest simulation techniques which provide a superb tool for learning: the Virtual PICmicro micro-controller. This is a simulation tool that allows users to write and execute MPASM assembler code for the PIC16F84 microcontroller on-screen. Using this you can actually see what happens inside the PICmicro MCU as each instruction is executed which enhances understanding.

- Comprehensive instruction through 45 tutorial sections
- Includes Vlab, a Virtual PICmicro microcontroller: a fully functioning simulator
- Tests, exercises and projects covering a wide range of PICmicro MCU applications
- Includes MPLAB assembler
- Visual representation of a PICmicro showing architecture and functions
- Expert system for code entry helps first time users
- Shows data flow and fetch execute cycle and has challenges (washing machine, lift, crossroads etc.)
- Imports MPASM files.



'C' FOR 16 Series PICmicro Version 4

The C for PICmicro microcontrollers CD-ROM is designed for students and professionals who need to learn how to program embedded microcontrollers in C. The CD contains a course as well as all the software tools needed to create Hex code for a wide range of PICmicro devices – including a full C compiler for a wide range of PICmicro devices.

Although the course focuses on the use of the PICmicro microcontrollers, this CD-ROM will provide a good grounding in C programming for any microcontroller.

- Complete course in C as well as C programming for PICmicro microcontrollers
- Highly interactive course
- Virtual C PICmicro improves understanding
- Includes a C compiler for a wide range of PICmicro devices
- Includes full Integrated Development Environment
- Includes MPLAB software
- Compatible with most PICmicro programmers
- Includes a compiler for all the PICmicro devices.



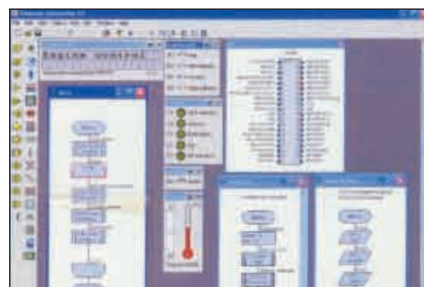
Minimum system requirements for these items: Pentium PC running Windows 98, NT, 2000, ME, XP; CD-ROM drive; 64MB RAM; 10MB hard disk space.

FLOWCODE FOR PICmicro V3

Flowcode is a very high level language programming system for PICmicro microcontrollers based on flowcharts. Flowcode allows you to design and simulate complex systems in a matter of minutes. A Powerful language that uses macros to facilitate the control of devices like 7-segment displays, motor controllers and I.c.d.'s. The use of macros allows you to control these devices without getting bogged down in understanding the programming.

Flowcode produces MPASM code which is compatible with virtually all PICmicro programmers. When used in conjunction with the Version 3 development board this provides a seamless solution that allows you to program chips in minutes.

- Requires no programming experience
- Allows complex PICmicro applications to be designed quickly
- Uses international standard flow chart symbols
- Full on-screen simulation allows debugging and speeds up the development process.
- Facilitates learning via a full suite of demonstration tutorials
- Produces ASM code for a range of 18, 28 and 40-pin devices
- New features in Version 3 include 16-bit arithmetic, strings and string manipulation, improved graphical user interface and printing, support for 18 series devices, pulse width modulation, I2C, new ADC component etc. The Hobbyist/Student version is limited to 4K of code (8K on 18F devices)



PRICES

Prices for each of the CD-ROMs above are:
(Order form on next page)

Hobbyist/Student	£45	inc VAT
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Institutional/Professional 10 user (Network Licence)	£300	plus VAT
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Enter any circuit (up to 100 nodes) within minutes with TINA's easy-to-use schematic editor. Enhance your schematics by adding text and graphics. Choose components from the large library containing more than 10,000 manufacturer models. Analyse your circuit through more than 20 different analysis modes or with 10 high tech virtual instruments. Present your results in TINA's sophisticated diagram windows, on virtual instruments, or in the live interactive mode where you can even edit your circuit during operation.

Customise presentations using TINA's advanced drawing tools to control text, fonts, axes, line width, colour and layout. You can create, and print documents directly inside TINA or cut and paste your results into your favourite word-processing or DTP package.

TINA includes the following Virtual Instruments: Oscilloscope, Function Generator, Multimeter, Signal Analyser/Bode Plotter, Network Analyser, Spectrum Analyser, Logic Analyser, Digital Signal Generator, XY Recorder.

Flowcode V3 (Hobbyist/Student) – For details on Flowcode, see the previous page.

This offer gives you two separate CD-ROMs in DVD style cases – the software will need registering (FREE) with Designsoft (TINA) and Matrix Multimedia (Flowcode), details are given within the packages.

Get TINA + Flowcode for a total of just £50, including VAT and postage.

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Click Data for a complete guide to the pin layouts of i.c.s, transistors etc. Click More Information for detailed background information with many animated diagrams.

Nearly all the circuits can be instantly simulated in Crocodile Technology* (not included on the CD-ROM) and you can customise the designs as required.

WHAT'S INCLUDED

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Runs in Microsoft Internet Explorer

*All circuits can be viewed, but can only be simulated if your computer has Crocodile Technology version 410 or later. A free trial version of Crocodile Technology can be downloaded from: www.crocodile-clips.com. Animated diagrams run without Crocodile Technology.

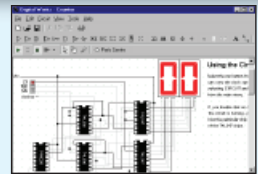
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Minimum system requirements for these CD-ROMs: Pentium PC, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 95/98/NT/2000/ME/XP, mouse, sound card, web browser.

DIGITAL WORKS 3.0



Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability.

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READOUT

Email: editorial@wimborne.co.uk

John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

All letters quoted here have previously been replied to directly



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★ LETTER OF THE MONTH ★

PCB de-soldering

Being an R & D engineer for a good number of years, I have had the occasion or two to remove soldered components from PCBs, and have tried various methods. Over the years, I have read several techniques on the art of removing soldered components from PCBs. Prompted by the letter in *Readout* and Alan's reply, I thought I would offer the two techniques that I have found most effective and least damaging to PCBs, tracks and plated through holes, as follows.

1. Apply a slightly hotter than normal soldering iron tip (I use an electronically adjustable tip-temperature iron) to the joint to melt the solder and with iron applied blast the joint with a jet of compressed air from a canister, the cans having a metal delivery tube are better than those with plastic tube as these tend to melt. This is not very health and safety considerate as hot molten solder flies everywhere, be sure to wear protective

gloves, goggles and a lab-coat, and perform the operation away from others.

I remove as much solder as possible from the joint prior to applying this technique with a heated de-soldering tool such as available from Rapid Electronics for less than £20.00 (see their stock code 85-0900). Most components can then be removed easily with a pair of thin-nosed pliers, or for ICs I use an extraction tool like that available from Rapid (stock code 22-0320) for less than £1.00.

2. Use a hot air gun to melt the solder and air-blast the joints as described above. I have a temperature controlled gun with a small nozzle and ensure that it is not applied for too long on any one area. Again, take care of molten solder splashes and use more conventional techniques to remove as much solder as possible prior to air-blasting.

Air blasting also cleans out the plated through holes nicely to allow replacement of the part. Both sides of the PCB will need a good brushing to remove the fine

deposits of solder, especially under ICs and similar. I use a small stiff plastic bristle brush for this.

Using the above techniques, I have recently removed successfully, and without damage to a double-sided PCB, a 68-pin SCSI connector. This item has four rows of 17 pins spaced just over 1mm apart, quite dense and without any easy way of cutting the component to remove pins individually.

I would recommend that, where possible, components are cut and leads or pins dealt with on an individual basis.

Tracks, especially if they are fine can be lifted and broken due to excessive heat and if the pins are a bit tight the plated through holes can be destroyed, but used with care and caution these techniques I have found to be very useful, especially with multi-pin components.

Ed Bye, via email

Thanks Ed, that sounds highly workable for those with the right gear.

Godfrey Manning's photospectrographs

Recently on the Chatzone (via www.epemag.co.uk) reader Derek posted the following:

I am so impressed with the photo-spectrographs by Godfrey Manning (*Readout* in the June issue), that I must ask if Mr Manning could tell us how he achieved such excellent results? However, I understand and respect that Mr Manning may not wish to make his research public, so can anyone offer a method of taking such pictures?

Knowing that Godfrey is not a CZer, I emailed him to ask how he did them. He replied:

The spectroscope is a basic prismatic device sold for educational purposes by Rapid Electronics (their order code 06-6560). The trouble is, it's meant to be looked down by eye at close quarters. I tried a so-called T-mount that enables a camera body to mount on a microscope, the eyepiece then projecting the image onto the focal plane of the camera. It didn't work.

So now I use a standard lens at close-focus extended by a macro tube, the T-mount goes on the filter ring of the lens (with appropriate adapters) and supports the spectroscope –

just. It's a bit wobbly. Great care is needed, it's not something I'd want to do too often. The plastic spectroscope has to physically rest against the lens – haven't scratched it so far. Some photographic expert out there is bound to have a better idea as to how to accomplish this!

Boris also responded on the CZ, suggesting Derek browsed: <http://en.wikipedia.org/wiki/Spectrometer>.

MIDI Drum Kit

Dear EPE,

I refer to the MIDI Drum Kit Pt4 (March '08 issue) page 65 – the box (red background, bottom right corner) headed 'Macintosh Computers' mentions the Yamaha UX96 USB-to-MIDI converter. Unfortunately, it is no longer available, so I purchased the Edirol UM-2 (made by Roland). If a computer has no MIDI port but is equipped with USB, this interface will add a MIDI input and two MIDI outputs.

What's more, it comes with a CD-ROM of drivers for all operating systems from Windows 98 to XP (with special instructions for Vista) and also for Mac OS. A product that thoughtfully acknowledges the existence of Windows 98 is rare these days! It also costs less than the Yamaha device. Surprisingly, it all installed quickly

and faultlessly on my 98SE system – that's saying something! I bought mine by mail order from Studiospares, tel: 08456 441020 or sales@studiospares.com (London NW2).

**Godfrey Manning G4GLM,
Edgware, Middx, by email**

Thanks for the info Godfrey

FTP Site

Dear EPE,

On the www.epemag.wimborne.co.uk website, the FTP pub\ area does not seem to match the Tree area. On the Tree I can see the artwork PDF files, but from the pub\ area the folder is not there.

I use an FTP manager to sync the files to my PC, but I have to go in manually and download the artwork from the Tree. Is this just me or can the data be moved?

**Mike Von Der Heyden,
Kimberley, South Africa, via email**

Alan replies:

Good point, Mike; the reason for this is because the PCB Artwork PDFs aren't hosted on the FTP site, they're hosted on the EPE web server for bandwidth and disk space reasons. The direct web link – in case this helps – is www.epemag.wimborne.co.uk/pcbs, sorted by month/issue/year. At the moment we don't have any solution to offer, but I'll work on it.

Alan Winstanley, via email

Net Work

Alan Winstanley



Putting on a MAC

Many Internet users will know the sinking feeling when they start to download a large file and, after an encouraging start, their sprightly download rate proceeds to fall off a cliff: the deliberate throttling back of data traffic by some service providers frustrates the efforts of avid Internet users engaged in fetching large music or video files, unless they leave their machine running overnight – a throwback to the dark dial-up days. In the writer's case, a theoretical 8Mbps tariff (2Mbps actual) via Tiscali ADSL was yielding a miserable 20 or 30kbps download at peak times.

This maddening performance, coupled with the higher monthly tariff compared with 'new customers only' rates, meant it was finally time for a change. In the UK, the procedure of switching broadband ISPs involves cancelling the existing service and obtaining a MAC (Migration Authorisation Code) from them to pass to the new provider. This must be done within a set timeframe or it automatically times out. In Tiscali's defence, after cancelling the service the process was 100% troublefree. The MAC code was emailed within the hour, confirmed in writing and the changeover took just seven days.

The new ADSL logins were duly delivered by the new ISP (Swift Internet) and configured in the router once the old service went down. The difference was immediately noticeable, particularly with large files that now download at a consistent 285kbps – roughly ten times faster than before.

Remember that ADSL services are contracted for typically 12 months, so you may not be able to move if you are locked into your current contract. When cancelling, you will lose any email or web addresses that are tied to your current broadband service. Apart from switching supplier via a MAC code, you could also cancel broadband altogether. It then takes BT approximately two weeks to remove the broadband tag on your line, until which time you cannot utilise any broadband supplier on that line at all.

ISPs that supply your broadband service are compelled to co-operate with transfer requests by issuing a MAC code. Details of the MAC transfer process and complaints procedure can be found at OFCOM's site at: www.ofcom.org.uk/consumeradvice/internet/service/switch/mac/

Linux – almost child's play?

Although *Net Work* is an Internet not a computer column, in recent issues I touched upon the subject of Linux, the alternative operating system that gives Windows XP a serious run for its money – especially as Linux is entirely free. My thanks go again to reader *Simon Faulkner*, who provided some helpful pointers. I must admit to having next to no experience of using Linux, which is only due to lack of time, and not because of any prejudice on my part.

I decided to start a new project to see how cheaply I could put together an Internet-enabled computer using free Linux and legacy computer parts. So, with an open mind I fetched Ubuntu from www.ubuntu.com, burned the 700MB image onto a CD and then spun it up on a spare old Dell PC. In what might be viewed as an act of divine Billgatesian intervention, the Dell's hard disk promptly self-destructed! This was possibly due to ageing in storage, but a second hard disk, scrounged off eBay especially for the job, joined its forebear in hard disk hell. Disappointingly, my zero-cost objective was defeated, which I put down to beginner's bad luck.

All went swimmingly well on a third hard disk, and I was soon experiencing the Linux front-end for the first time – a clean and attractive GUI being viewed on a (free) high-end Iiyama CRT monitor. The USB mouse was found without a problem. Helped by some Linux books (from an Oxfam bookshop – this is about price, remember!) I configured the toolbar, found my way to the all-essential Terminal program and started to find my way around.

I am sorry to disappoint my Linux-loving readers, but progress is presently stalled by the need to install a USB wi-fi adaptor, wrapping a Linux shell around a suitable Windows driver. This highlights one drawback, namely the need for arcane command-line operations that are not intuitive to seasoned Windows users; my limited experience tends to reaffirm my belief that installing Linux the first time is a task for computer enthusiasts having some time on their hands. Even so, the necessary information can be Googled and it is only a question of devoting resources to completing the project in 'slow time'. I guess it is easy when you know how – watch this space.

Setup issues aside, Linux is an elegant OS that is literally child's play to use. As a sign of things to come, the Asus Eee PC (<http://eeeepc.asus.com/global/product.htm>) is a very cheap (from £200) small screen laptop with a choice of Linux or Windows. Although initially designed for children, its desirable features include a solid state disk (from 2GB) and very compact form factor that will appeal to mobile Internet workers. It is a dinky thing and I was impressed by some quick keyboard trials; *EPE* contributor *Thomas Scarborough* in Cape Town is pleased by the bundled office software, but less so by the heat output. For many general Internet users on the move, the novel Asus Eee PC may be a breath of fresh air that offers the mass market a refreshing introduction to Linux.

In forthcoming articles I will describe the fly-on-the-wall view of a real-life Internet money laundering fraud, and point to some DOS-based tools to check your internet setup. I will also look at online techniques to analyse domain name ownership, networks and web site hosting will also be outlined. Readers can email Alan at: alan@epemag.demon.co.uk



The Asus Eee PC range is an extremely capable mini laptop running Linux or Windows, with a solid-state disk and 802.11g wifi that's finding favour amongst professional, mobile workers, families and young users alike

DIRECT BOOK SERVICE

Electronics Teach-In + FREE CD-ROM

Mike Tooley

A broad-based introduction to electronics – find out how circuits work and what goes on inside them. Plus 15 easy-to-build projects. The 152 page A4 book comes with a free CD-ROM containing the whole Teach-In 2006 series (originally published in EPE) in PDF form, interactive quizzes to test your knowledge, TINA circuitsimulation software (a limited version – plus a specially written TINA Tutorial), together with simulations of the circuits in the Teach-In series, plus Flowcode (a limited version) a high level programming system for PIC microcontrollers based on flowcharts.

The Teach-In series covers everything from Electric Current through to Microprocessors and Microcontrollers and each part includes demonstration circuits to build on breadboards or to simulate on your PC.

In addition to the Teach-In series, the book includes 15 CMOS-based simple projects from the Back-To-Basics series by Bart Trepak, these are: Fridge/Freezer Alarm, Water Level Detector, Burglar Alarm, Scarecrow, Digital Lock, Doorchime, Electronic Dice, Kitchen Timer, Room Thermometer, Daily Reminder, Whistle Switch, Parking Radar, Telephone Switch, Noughts and Crosses Enigma and a Weather Vane. There is also a MW/LW Radio project in the Teach-In series.

152 pages + CD-ROM **Order code ETI** £8.50



CIRCUITS AND DESIGN

A BEGINNER'S GUIDE TO TTL DIGITAL ICs R. A. Penfold

This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world".

142 pages **Order code BP332** £5.45

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M. Bridges the gap between complicated technical theory, and "cut-and-try" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias – tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-Current Circuits, Passive Components, Alternating-Current Circuits, Networks and Theorems, Measurements.

256 pages **Order code BP53** £5.49

MICROCONTROLLER COOKBOOK Mike James

The practical solutions to real problems shown in this cookbook provide the basis to make PIC and 8051 devices really work. Capabilities of the variants are examined, and ways to enhance these are shown. A survey of common interface devices, and a description of programming models, lead on to a section on development techniques. The cookbook offers an introduction that will allow any user, novice or experienced, to make the most of microcontrollers.

240 pages **Order code NE 26** £23.50

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

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2

COMPUTING AND ROBOTICS

WINDOWS XP EXPLAINED N. Kantaris and P. R. M. Oliver

If you want to know what to do next when confronted with Microsoft's Windows XP screen, then this book is for you. It applies to both the Professional and Home editions. The book was written with the non-expert, busy person in mind. It explains what hardware requirements you need in order to run Windows XP successfully, and gives an overview of the Windows XP environment.

The book explains: How to manipulate Windows, and how to use the Control Panel to add or change your printer, and control your display; How to control information using WordPad, notepad and paint, and how to use the Clipboard facility to transfer information between Windows applications; How to be in control of your filing system using Windows Explorer and My Computer; How to control printers, fonts, characters, multimedia and images, and how to add hardware and software to your system; How to configure your system to communicate with the outside world, and use Outlook Express for all your email requirements; how to use the Windows Media Player 8 to play your CDs, burn CDs with your favourite tracks, use the Radio Tuner, transfer your videos to your PC, and how to use the Sound Recorder and Movie Maker; How to use the System Tools to restore your system to a previously working state, using Microsoft's Website to update your Windows set-up, how to clean up, defragment and scan your hard disk, and how to backup and restore your data; How to successfully transfer text from those old but cherished MS-DOS programs.

264 pages **Order code BP514** £7.99

INTRODUCING ROBOTICS WITH LEGO MINDSTORMS Robert Penfold

Shows the reader how to build a variety of increasingly sophisticated computer controlled robots using the brilliant Lego Mindstorms Robotic Invention System (RIS). Initially covers fundamental building techniques and mechanics needed to construct strong and efficient robots using the various "click-together" components supplied in the basic RIS kit. Explains in simple terms how the "brain" of the robot may be programmed on screen using a PC and "zapped" to the robot over an infrared link. Also, shows how a more sophisticated Windows programming language such as Visual BASIC may be used to control the robots.

Detailed building and programming instructions provided, including numerous step-by-step photographs.

288 pages + Large Format **Order code BP901** £14.99

MORE ADVANCED ROBOTICS WITH LEGO MINDSTORMS – Robert Penfold

Shows the reader how to extend the capabilities of the brilliant Lego Mindstorms Robotic Invention System (RIS) by using lego's own accessories and some simple home constructed units. You will be able to build robots that can provide you with 'waiter service' when you clap your hands, perform tricks, 'see' and

Covers the Vision
command system

avoid objects by using 'bats radar', or accurately follow a line marked on the floor. Learn to use additional types of sensors including rotation, light, temperature, sound and ultrasonic and also explore the possibilities provided by using an additional (third) motor. For the less experienced, RCX code programs accompany most of the featured robots. However, the more adventurous reader is also shown how to write programs using Microsoft's VisualBASIC running with the ActiveX control (Spirit.OCX) that is provided with the RIS kit.

Detailed building instructions are provided for the featured robots, including numerous step-by-step photographs. The designs include rover vehicles, a virtual pet, a robot arm, an 'intelligent' sweet dispenser and a colour conscious robot that will try to grab objects of a specific colour.

298 pages **Order code BP902** £14.99

THE PIC MICROCONTROLLER YOUR PERSONAL INTRODUCTORY COURSE – THIRD EDITION John Morton

Discover the potential of the PIC microcontroller through graded projects – this book could revolutionise your electronics construction work!

A uniquely concise and practical guide to getting up and running with the PIC Microcontroller. The PIC is one of the most popular of the microcontrollers that are transforming electronic project work and product design.

Assuming no prior knowledge of microcontrollers and introducing the PICs capabilities through simple projects, this book is ideal for use in schools and colleges. It is the ideal introduction for students, teachers, technicians and electronics enthusiasts. The step-by-step explanations make it ideal for self-study too: this is not a reference book – you start work with the PIC straight away.

The revised third edition covers the popular reprogrammable Flash PICs: 16F54/16F84 as well as the 12F508 and 12F675.

270 pages **Order code NE36** £18.50

INTRODUCTION TO MICROPROCESSORS AND MICROCONTROLLERS – SECOND EDITION John Crisp

If you are, or soon will be, involved in the use of microprocessors and microcontrollers, this practical introduction is essential reading. This book provides a thoroughly readable introduction to microprocessors and microcontrollers. Assuming no previous knowledge of the subject, nor a technical or mathematical background. It is suitable for students, technicians, engineers and hobbyists, and covers the full range of modern micros.

After a thorough introduction to the subject, ideas are developed progressively in a well-structured format. All technical terms are carefully introduced and subjects which have proved difficult, for example 2's complement, are clearly explained. John Crisp covers the complete range of microprocessors from the popular 4-bit and 8-bit designs to today's super-fast 32-bit and 64-bit versions that power PCs and engine management systems etc.

222 pages **Order code NE31** £22.00

EASY PC CASE MODDING R.A. Penfold

Why not turn that anonymous grey tower, that is the heart of your computer system, into a source of visual wonderment and fascination. To start, you need to change the case or some case panels for ones that are transparent. This will then allow the inside of your computer and it's working parts to be clearly visible.

There are now numerous accessories that are relatively inexpensive and freely available, for those wishing to customise their PC with added colour and light. Cables and fans can be made to glow, interior lights can be added, and it can all be seen to good effect through the transparent case. Exterior lighting and many other attractive accessories may also be fitted.

This, in essence, is case modding or PC Customising as it is sometimes called and this book provides all the practical details you need for using the main types of case modding components including:- Electro luminescent (EL) 'go-faster' stripes: Internal lighting units: Fancy EL panels: Data cables with built-in lighting: Data cables that glow with the aid of 'black' light from an ultraviolet (UV) tube: Digital display panels: LED case and heatsink fans: Coloured power supply covers.

192 pages + CD-ROM **Order code BP542** £8.99

ROBOT BUILDERS COOKBOOK Owen Bishop

This is a project book and guide for anyone who wants to build and design robots that work first time.

With this book you can get up and running quickly, building fun and intriguing robots from step-by-step instructions. Through hands-on project work, Owen introduces the programming, electronics and mechanics involved in practical robot design-and-build. The use of the PIC microcontroller throughout provides a painless introduction to programming – harnessing the power of a highly popular microcontroller used by students, hobbyists and design engineers worldwide.

Ideal for first-time robot builders, advanced builders wanting to know more about programming robots, and students tackling microcontroller-based practical work and labs.

The book's companion website at <http://books.elsevier.com/companions/9780750665568> contains: downloadable files of all the programs and subroutines; program listings for the Quester and the Gantry robots that are too long to be included in the book.

366 pages **Order code NE46** £21.99

NEWNES INTERFACING COMPANION Tony Fischer-Cripps

A uniquely concise and practical guide to the hardware, applications and design issues involved in computer interfacing and the use of transducers and instrumentation. Newnes Interfacing Companion presents the essential information needed to design a PC-based interfacing system from the selection of suitable transducers, to collection of data, and the appropriate signal processing and conditioning.

Contents: Part 1 – Transducers; Measurement systems; Temperature; Light; Position and motion; Force, pressure and flow. Part 2 – Interfacing; Number systems; Computer architecture; Assembly language; Interfacing; A to D and D to A conversions; Data communications; Programmable logic controllers; Data acquisition project. Part 3 – Signal processing; Transfer function; Active filters; Instrumentation amplifier; Noise; Digital signal processing.

295 pages **Order code NE38** £31.00

THEORY AND REFERENCE

THE AMATEUR SCIENTIST CD-ROM

The complete collection of The Amateur Scientist articles from Scientific American magazine. Over 1,000 classic science projects from a renowned source of winning projects. All projects are rated for cost, difficulty and possible hazards.

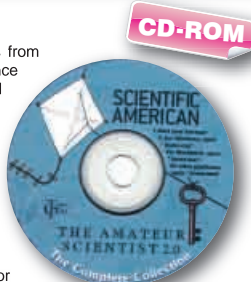
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Exciting science projects in: Astronomy; Earth Science; Biology; Physics; Chemistry; Weather . . . and much more! The most complete resource ever assembled for hobbyists, and professionals looking for novel solutions to research problems.

Includes extensive Science Software Library with even more science tools. Suitable for Mac, Windows, Linux or UNIX. 32MB RAM minimum, Netscape 4.0 or higher or Internet Explorer 4.0 or higher.

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BEBOP BYTES BACK (and the Bebop Computer Simulator) CD-ROM Clive (Max) Maxfield and Alvin Brown

This follow-on to Bebop to the Boolean Boogie is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . .

. . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the CD-ROM contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the CD-ROM contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this!

Over 800 pages in Adobe Acrobat format

Order code BEB2 CD-ROM £21.95



GETTING THE MOST FROM YOUR MULTIMETER R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic products.

96 pages

Order code BP239 £5.49

OSCILLOSCOPES - FIFTH EDITION Ian Hickman

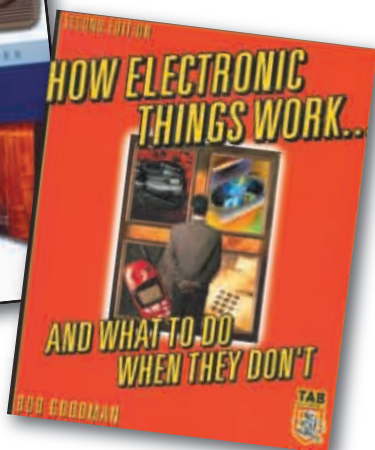
Oscilloscopes are essential tools for checking circuit operation and diagnosing faults, and an enormous range of models are available.

This handy guide to oscilloscopes is essential reading for anyone who has to use a 'scope for their work or hobby; electronics designers, technicians, anyone in industry involved in test and measurement, electronics enthusiasts . . . Ian Hickman's review of all the latest types of 'scope currently available will prove especially useful for anyone planning to buy - or even build - an oscilloscope.

The contents include a description of the basic oscilloscope; Advanced real-time oscilloscope; Accessories; Using oscilloscopes; Sampling oscilloscopes; Digital storage oscilloscopes; Oscilloscopes for special purposes; How oscilloscopes work (1): the CRT; How oscilloscopes work (2): circuitry; How oscilloscopes work (3): storage CRTs; plus a listing of Oscilloscope manufacturers and suppliers.

288 pages

Order code NE37 £24.00



PRACTICAL ELECTRONIC FAULT FINDING AND TROUBLESHOOTING Robin Pain

To be a real fault finder, you must be able to get a feel for what is going on in the circuit you are examining. In this book Robin Pain explains the basic techniques needed to be a fault finder.

Simple circuit examples are used to illustrate principles and concepts fundamental to the process of fault finding. This is not a book of theory, it is a book of practical tips, hints and rules of thumb, all of which will equip the reader to tackle any job. You may be an engineer or technician in search of information and guidance, a college student, a hobbyist building a project from a magazine, or simply a keen self-taught amateur who is interested in electronic fault finding but finds books on the subject too mathematical or specialised.

The fundamental principles of analogue and digital fault finding are described (although, of course, there is no such thing as a "digital fault" - all faults are by nature analogue). This book is written entirely for a fault finder using only the basic fault-finding equipment: a digital multimeter and an oscilloscope. The treatment is non-mathematical (apart from Ohm's law) and all jargon is strictly avoided.

274 pages

Order code NE22 £28.99

ELECTRONIC TEST EQUIPMENT HANDBOOK Steve Money

In most applications of electronics, test instruments are essential for checking the performance of a system or for diagnosing faults in operation, and so it is important for engineers, technicians, students and hobbyists to understand how the basic test instruments work and how they can be used.

The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of these instruments are also examined.

206 pages

Order code PC109 £9.95

DIGITAL GATES AND FLIP-FLOPS Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages

Order code PC106 £9.05

UNDERSTANDING ELECTRONIC CONTROL SYSTEMS Owen Bishop

Owen Bishop has produced a concise, readable text to introduce a wide range of students, technicians and professionals to an important area of electronics. Control is a highly mathematical subject, but here maths is kept to a minimum, with flow charts to illustrate principles and techniques instead of equations.

Cutting edge topics such as microcontrollers, neural networks and fuzzy control are all here, making this an ideal refresher course for those working in industry. Basic principles, control algorithms and hardware control systems are also fully covered so the resulting book is a comprehensive text and well suited to college courses or background reading for university students.

The text is supported by questions under the headings Keeping Up and Test Your Knowledge so that the reader can develop a sound understanding and the ability to apply the techniques they are learning.

228 pages

Order code NE35 £22.50

HOW ELECTRONIC THINGS WORK - AND WHAT TO DO WHEN THEY DON'T Robert Goodman

You never again have to be flummoxed, flustered or taken for a ride by a piece of electronics equipment. With this fully illustrated, simple-to-use guide, you will get a grasp on the workings of the electronic world that surrounds you - and even learn to make your own repairs.

You don't need any technical experience. This book gives you: Clear explanations of how things work, written in everyday language. Easy-to-follow, illustrated instructions on using test equipment to diagnose problems. Guidelines to help you decide for or against professional repair. Tips on protecting your expensive equipment from lightning and other electrical damage. Lubrication and maintenance suggestions.

Covers: colour TVs, VCRs, radios, PCs, CD players, printers, telephones, monitors, camcorders, satellite dishes, and much more!

394 pages

Order code MGH3 £21.99

VINTAGE RADIOS Tony Thompson

Since the 1920s the radio set has been an important part of most people's lives. In the thirties and forties the wireless was an important piece of furniture and a potent symbol of status; beautifully made floor-standing and table-top sets in veneered wood and trendy Bakelite became the focal points of living rooms up and down the land. After the war the emphasis began to change towards portability, and the change from valves to transistors in the 1960s changed the radio into a more useful but far less interesting object.

The book tells the collector, and the armchair wireless enthusiast, everything he or she needs to know about classic radios from the 1920s to the end of the 1960s. All the important makes and models are discussed, and the author also covers buying and selling, care and restoration, and many other topics, including foreign radios and radio-related ephemera.

Illustrated with hundreds of colour photographs, this is the perfect collector's companion to the fascinating topic.

208 pages - hardback

Order code CVR £21.95

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PROJECT BUILDING

ELECTRONIC PROJECT BUILDING FOR BEGINNERS

R. A. Penfold

This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics: Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding. In fact everything you need to know in order to get started in this absorbing and creative hobby.

135 pages

Order code BP392 £5.49

BUILDING VALVE AMPLIFIERS

Morgan Jones

The practical guide to building, modifying, fault-finding and repairing valve amplifiers. A hands-on approach to valve electronics – classic and modern – with a minimum of theory. Planning, fault-finding, and testing are each illustrated by step-by-step examples.

A unique hands-on guide for anyone working with valve (tube in USA) audio equipment – as an electronics experimenter, audiophile or audio engineer.

Particular attention has been paid to answering questions commonly asked by newcomers to the world of the vacuum tube, whether audio enthusiasts tackling their first build, or more experienced amplifier designers seeking to learn the ropes of working with valves. The practical side of this book is reinforced by numerous clear illustrations throughout.

368 pages

Order code NE40 £22.50

THEORY AND REFERENCE

THE EMERGENCE OF BROADCASTING IN BRITAIN

Brian Hennessy

The beginning of any great enterprise should be recorded for posterity. Few knew that the Children's Hour "Uncles", Arthur, Jeff and Caractacus, were also the engineers who struggled by day to develop technical equipment – and would soon become Assistant Controller, Station Director and Organiser of Programmes for the BBC.

This is a very human account, from the dawn of radio to the attainment of a Royal Charter in the late 1920s. It tells of the struggles and frustrations of engineers in developing innovative equipment and of the great John Reith who battled with everyone to bring the BBC from a staff of four up to a Corporation of several hundred.

Brian Hennessy's book also describes the development of broadcasting equipment, the search for premises and looming bankruptcy before ending with the emergence of a firmly established Chartered Corporation – the BBC.

Meticulous research over many years, over a hundred photographs, plans and diagrams as well as interviews with many of those who were there at the time, make this a valuable and original work for those involved in media studies, for radio enthusiasts or simply for those interested in radio and the fascinating story of the emergence of broadcasting.

436 pages

Order code EBB £26.00



PRACTICAL ELECTRONIC FILTERS

Owen Bishop

This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.

The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rhythm sequencer and a multi-voiced electronic organ.

Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.

188 pages

Order code BP299 £5.45

ELECTRONIC PROJECTS FOR EXPERIMENTERS

R. A. Penfold

Many electronic hobbyists who have been pursuing their hobby for a number of years seem to suffer from the dreaded "seen it all before" syndrome. This book is fairly and squarely aimed at sufferers of this complaint, plus any other electronics enthusiasts who yearn to try something a bit different.

The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.

138 pages

Order code BP371 £5.45

PRACTICAL FIBRE-OPTIC PROJECTS

R. A. Penfold

While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.

The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.

All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.

132 pages

Order code BP374 £5.45

STARTING ELECTRONICS, THIRD EDITION

KEITH BRINDLEY

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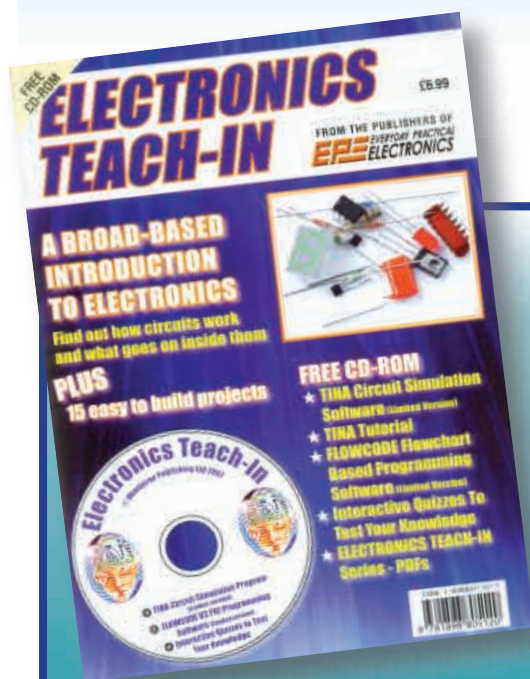
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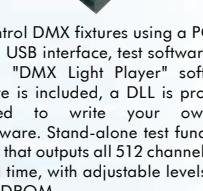
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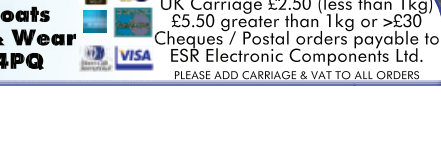
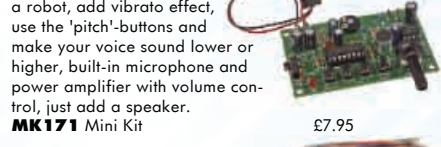
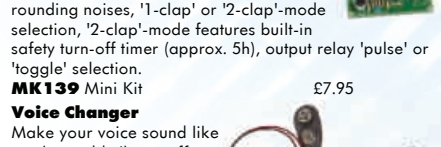
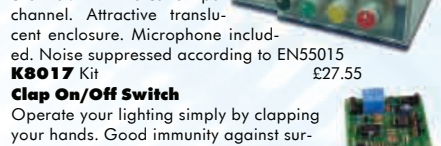
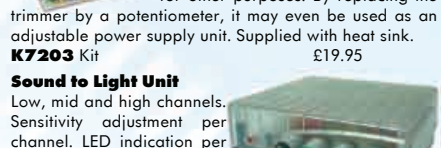
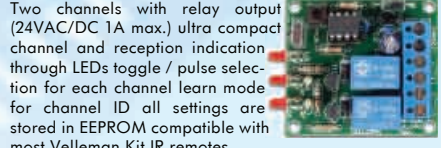
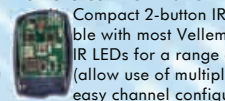
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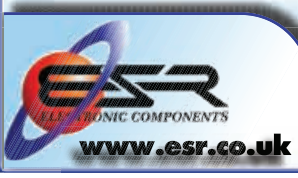
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Fax: +44 (0) 1756 752857

Registered Address: 53-55 Main Street, Grassington, North Yorks, UK, BD23 5AA